tech engineering news

april

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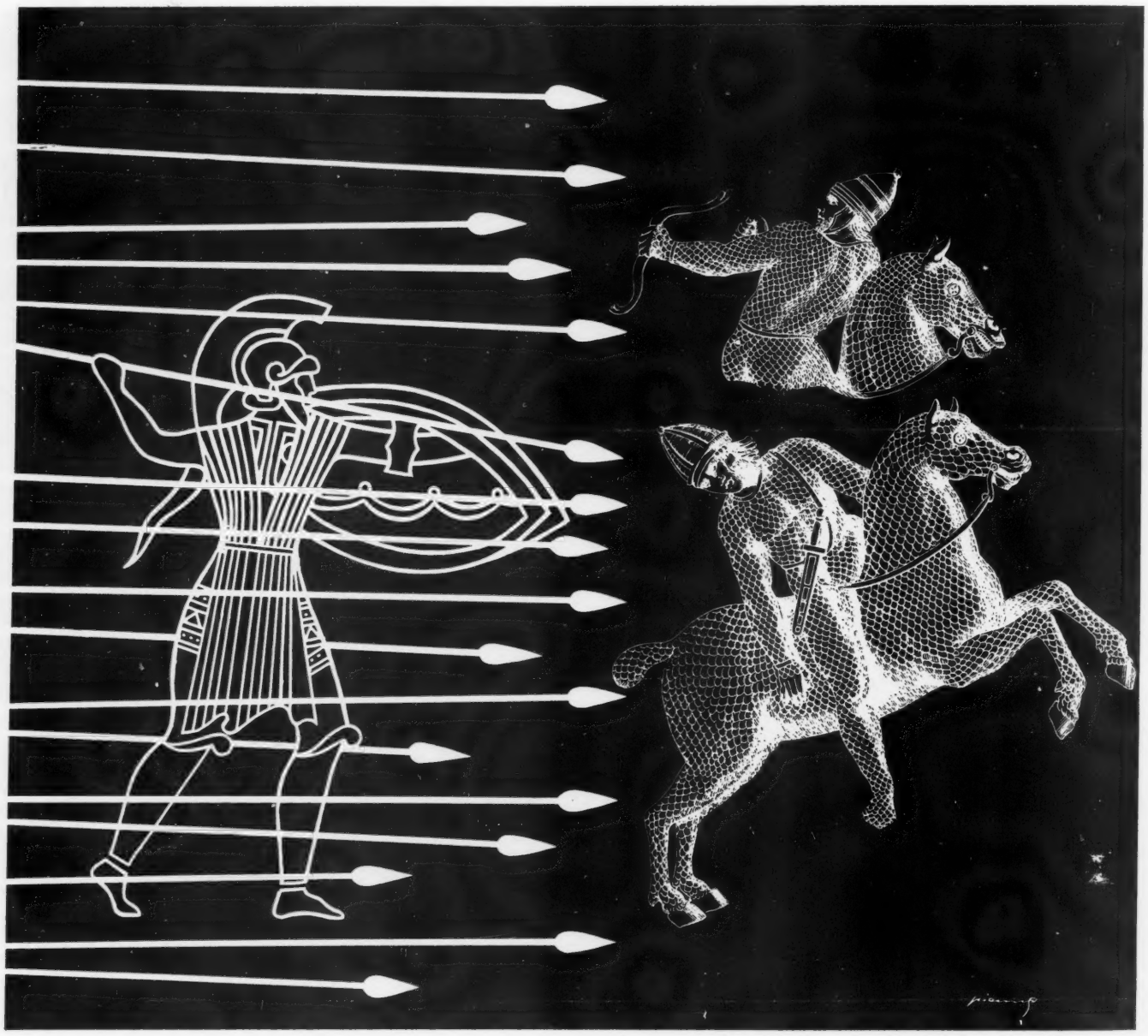

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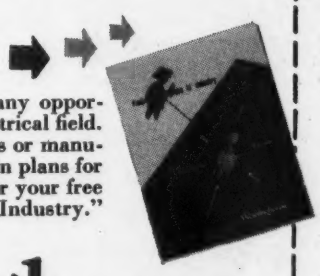
to direct installation and repair at the customer's plants; to handle emergency breakdowns. G-10003



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A BEARING QUIZ FOR STUDENT ENGINEERS

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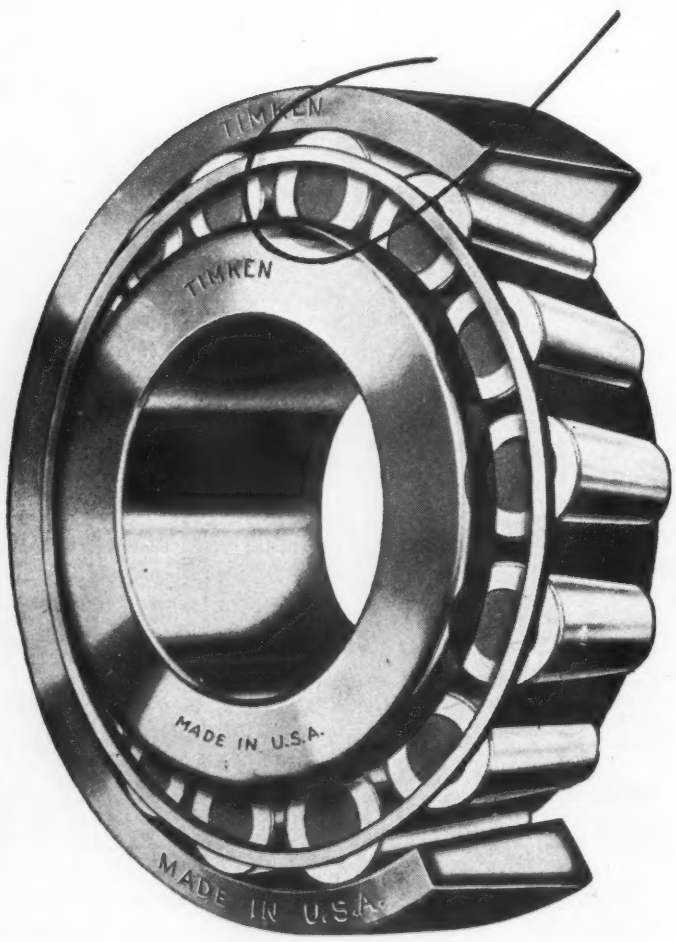
Do you know that the Timken Roller Bearing is more than an anti-friction bearing; more than a radial load bearing? That it is an all-load bearing — can carry, all at once, radial loads, thrust loads, and any combination of them with full efficiency and certainty?

Do you know that the Timken Bearing was introduced nearly 50 years ago and has undergone constant engineering development and refinement ever since? That the Timken-developed process of Generated Unit Assembly produces true spherical (convex-concave) contact between the large ends of the rolls and the rib or flange of the cone thereby reducing friction and initial wear to a minimum; assuring correct alignment of the rolls with respect to the races; helping to distribute the loads evenly throughout the bearing; decreasing operating temperatures; producing quieter running; and last, but not least, assuring that when the bearing is properly mounted no further adjustment is required?



Do you know that the special alloy steel from which Timken Bearings are made was developed in our own metallurgical laboratories and is produced in our own steel plant? That the Timken Bearing is the only bearing manufactured under one roof from raw material to finished product?

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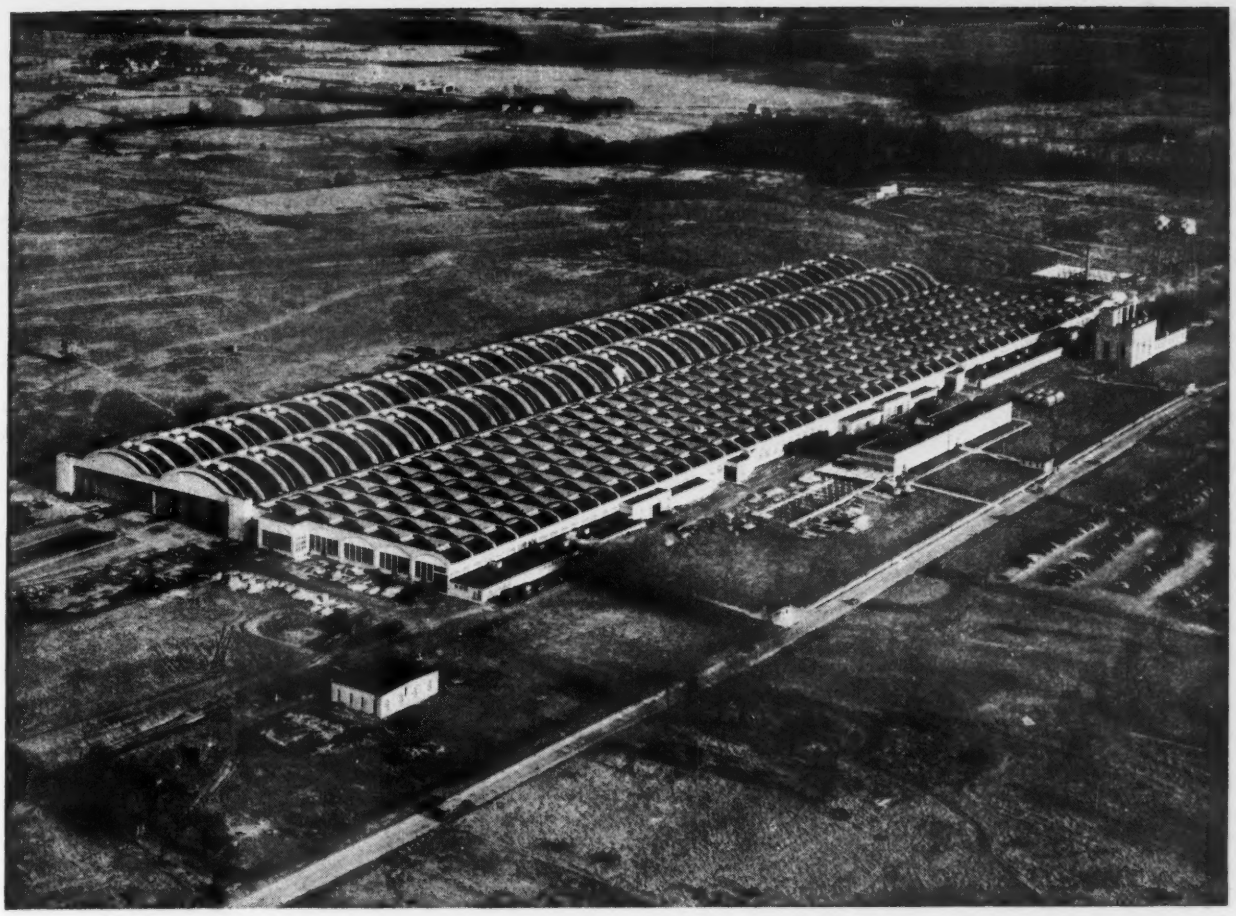

Budd plant on Red Lion Road, near Bustleton

HERE IS WHERE BUDD TRAINS ARE BUILT

This new plant has been converted from war production and is now turning out the famous Budd stainless steel trains.

The plant is enormous and splendidly equipped. It provides ample room for the fabricating of eighty cars at one time. And it also provides jobs for thousands of men and women.

New stainless steel cars are rolling out—joining the blue ribbon fleets of many of the nation's foremost railroads.

These new cars are true post war creations. Budd is utilizing to the fullest the technical advances of the past six years. We have reason to believe they are the best trains that have ever been built.

Budd

Briefing the News . . .

Rocket Exhaust Gases . . .

IN the search for a rocket that will out-perform the German V-2 and climb still further into the earth's outer atmosphere, scientists have been seriously hindered by their lack of knowledge about the velocity with which hot gases are expelled from a rocket. If it were interjected into the streaming gas any measuring instrument would be instantly vaporized, and even if it could possibly withstand the extreme temperatures, it would so disturb the thousand-mile-a-minute flow of gas that measurements would be useless.

From General Electric, however, comes news that a group of their scientists have perfected a device for simultaneously measuring the temperature and the velocity of the burning gases. The instrument employs the principle by which the velocities of distant stars and the speed of rotation of the sun are now measured by astronomers.

The instrument uses the principle of the Doppler effect, according to which the frequency of a sound or light wave sent out by a moving body is greater in the direction of motion than in the opposite direction, whereas its radiation at right angles to the direction of motion is its normal radiation frequency when at rest. This is the reason that a train whistle sounds so high-pitched when it is approaching, but drops abruptly in pitch as the train passes. The same principle is applied to starlight to measure the velocity of stars. The light given off by a star is examined with a sensitive spectrometer. If a certain spectral line is in its normal position, the star is neither approaching nor moving away. If the line is shifted toward the violet or high frequency end of the visible spectrum, the star is approaching, whereas if the line is shifted toward the red end of the spectrum, the star is receding. Since the spectral lines of the more distant stars are shifted toward the red end of the spectrum, the stars appear to be moving away from the earth in all directions, and this phenomenon has given rise to the theory of the expanding universe.

The General Electric scientists set out to measure the velocity of the exhaust gases of a rocket by this means. The task was very difficult because of the small shift involved, but the scientists overcame this obstacle by using two spectroscopes, one examining the escaping gases from the rear and the other examined them from alongside. The yellow line of sodium was selected for the examination. In the spectroscope beside the stream of gas the sodium line was in its normal position, but in the instrument placed at the rear it was found to be shifted slightly toward the violet end of the spectrum. The sodium lines produced in the two spectrometers were superimposed in an interferometer. If they had exactly the same frequency, the waves would have produced no interference pattern, but, due to the slight difference in their frequencies, the waves produced an interference pattern consisting of a series of light and dark rings which could be photographed on a photographic plate. By measuring the separation of the rings, the scientists were enabled to tell the difference in the frequencies of the two spectral lines and thus the velocity of the exhaust gases.

Naming the Heaviest Atoms . . .

A little over a decade ago the elements were thought to be ninety-two in number, hydrogen being the lightest and uranium being the heaviest of the lot. Since then, however, four new elements have been added to the atomic list, two of which were formed by the atomic pile. Element 93 is neptunium, and together with plutonium, element 94, is produced by the interaction of uranium and neutrons in the atomic pile. Element 95 has been named americium, in honor of all the Americas, and element 96, the heaviest of all, has been named curium, after the great scientists of radioactivity, Pierre and Madame Curie.

Smallest Phototube . . .

The smallest photoelectric tube ever developed for sale is RCA's new tube 1P42. It is only an inch and a half long, while the end, through which the light enters, is only one-fourth inch in diameter.

The tube is nearly as sensitive as large phototubes, and can be installed in a much smaller space than the conventional ones.

Electrostatic Paint Spraying . . .

The principle of electric precipitation of smoke in chimneys has been applied to paint spraying. The object to be sprayed is given a highly electric charge relative to the paint spraying apparatus. As a result the small highly charged paint drops are attracted to the surface and adhere to it.

The process was used during the war on small objects, and has now been applied to much larger objects. The efficiency of the new method is much greater than the usual method of spraying paint. Only half as much paint is used, and only a third as much labor is required.

How to Clean a River . . .

The people of Louisville, Kentucky, were complaining. The many large rubber plants along the Ohio River had been disposing of their waste products by dumping them into the river. Finally the odor of decomposing sulfur compounds became too great to bear, and the population in the vicinity demanded that the matter be called to a halt.

Dr. Fleishman of the Covington, Kentucky, filtration plant found a solution to the problem. He dumped a quantity of sulfur into the river. This encouraged the growth of sulfur-consuming bacteria, which soon consumed not only the sulfur thrown into the river but the decomposing waste products as well. Soon the water had lost its odor, and science had won another victory.

A New Magnetic Alloy . . .

From the Bell Telephone laboratories comes news of a new easily-magnetized alloy called *supermalloy*, a super-magnetic alloy of iron, nickel and molybdenum. It has an extremely high magnetic permeability, over five hundred times that of iron and more than two hundred times that of silicon steel, the alloy used in the cores of transformers.

The new magnetic material has a very low hysteresis loss under low magnetizing forces, and hence is expected

to come into very extensive use in voice-frequency transformers for radio and telephone work, for with the new alloy the frequency range that can be transformed is increased threefold. Under high magnetizing forces, however, the material becomes saturated, and thus seems to be impractical for use in power transformers.

Oil Recovery Chemical . . .

A new chemical, Dresinol, which substantially reduces the cost of the secondary recovery of oil from wells by flooding them with water, was revealed by Mr. Donald Martin, of the Hercules Powder Company.

One of the principal ways of recovering oil from wells in which it is not longer flowing freely is to pump water into the oil sands to displace the oil. In the past it was not possible to force out economically the enormous deposits of crude oil in the more tightly packed layers of sand, however. Water forced down the intake well would naturally first seep into loosely packed sand strata which had already been drained of oil. To offset this, it was necessary to greatly increase the amount of water so that some pressure would be exerted on the more tightly packed sands. However, too often the cost for doing so was prohibitive.

The situation has been greatly altered by the discovery of dresinol, a selective plugging agent, which is pumped down the water intake of wells. Because there is less resistance to pressure in the loosely packed sands, the dresinol solution flows into these layers, and in a matter of hours these layers become almost impervious to the penetration of water. After the porous layers of sand have been plugged, water can be forced down the well and the deep-seated oil extracted with a fraction of the original quantity of water.

A Sensitive, Portable Radiation Detector . . .

With the advent of the atomic era, it has become important to have a portable radiation detector which can be used to discover radioactive deposits and to warn one against radioactive substances produced by an atomic pile. The Phillips Company reports that it has developed a portable Geiger-counter radiation detector weighing 17 pounds.

For use in such devices as the portable Geiger counter and electron multiplier tubes, the Eveready Company has designed a 300-volt battery, 2½ inches wide and 4 inches high, weighing 1 pound. It will last for over 300 hours under minute current drains, but if the current rises over a few microamperes, the battery is quickly discharged.

Fragments of the Moon . . .

Mr. H. H. Nininger, a noted American authority on meteorites, has come out with the theory that certain glassy meteorites, called tektites, which strike the earth are fragments of the moon which have been blasted from it by the impact of the iron and nickel meteorites traveling through space.

The reason that the tektites form and reach the earth, says Mr. Nininger, is that the moon has no atmosphere to protect it from the impact of visiting meteors. A high-velocity meteor would undoubtedly generate an enormous quantity of heat on colliding with the moon, and molten fragments of the moon would undoubtedly be ejected. Since the moon's gravitational field is far weaker than the earth's, some of these particles might escape from the moon and enter the earth's gravitational field, eventually striking the earth.

As evidence, Mr. Niniger points out that the tektites appear to have been melted twice in the course to the earth, the first time presumably on the moon's surface and the second time through friction in the earth's atmosphere.

New High Vacuum Leak Detector . . .

Reaching the all-time high for Rube Goldberg machines is the University of Minnesota's latest leak detector for discovering tiny leaks in vacuum tubes and other high vacuum apparatus. The apparatus is tested by playing a fine jet of helium gas over the surface of the evacuated equipment. When the helium jet strikes a leak in the surface, a meter on the testing equipment indicates it within a few seconds, and thus the leak can be sealed or the apparatus discarded.

As the stream of helium strikes a tiny hole in the apparatus being tested, the helium molecules are carried by a high vacuum line into a mass spectrometer. There a hot filament ionizes the helium to form He_+ ions, which are accelerated away from the filament by several highly negative electrodes. The beam of ions then passes through a magnetic field, and is bent through a certain angle. All other ions are bent through a different angle, and hence fail to go through a small hole in a negatively charged plate through which the helium ion beam is next passed. The helium ion beam is then decelerated by passing through a positively charged ring and is then allowed to fall on the collector plate of the spectroscope.

The spectroscope collector is connected directly to the control grid of a vacuum tube amplifier built into the spectrometer itself.

The output of the amplifier is then passed to a direct-coupled high-gain amplifier, and the output current of this amplifier is read on a milliammeter. Thus as soon as the helium jet strikes the leaky apparatus, the milliammeter reading indicates the extent of the leakage.

The mass-spectrograph high-vacuum leak detector was developed to discover leaks in gaseous diffusion plants for the separation of U-235, the uranium isotope that was used to make the atomic bomb. A high vacuum had to be maintained in a large piece of apparatus for long periods of time, and hence a highly efficient leak detector became imperative. The mass spectrograph is an extremely sensitive instrument, being able to detect leakages of .01 micron-cubic-feet per hour, or the amount of gas that would build up a pressure of .01 microns (2×10^{-7} lbs./sq. in.) in a volume of one cubic foot in a period of an hour. The ability of the spectrometer to distinguish the entering helium from the small amount of air already present is also remarkable, for the apparatus can detect ten parts per million of helium in air.

In spite of the complexity of the instrument, the University of Minnesota's spectrograph has been designed on a small scale so that it is portable, and the new instrument will undoubtedly become a commercially available instrument in the future. The Radio Corporation of America is using a similar piece of apparatus in testing for leaks in vacuum tubes, and has reported that the new machine has performed a service which far outweighs its cost.

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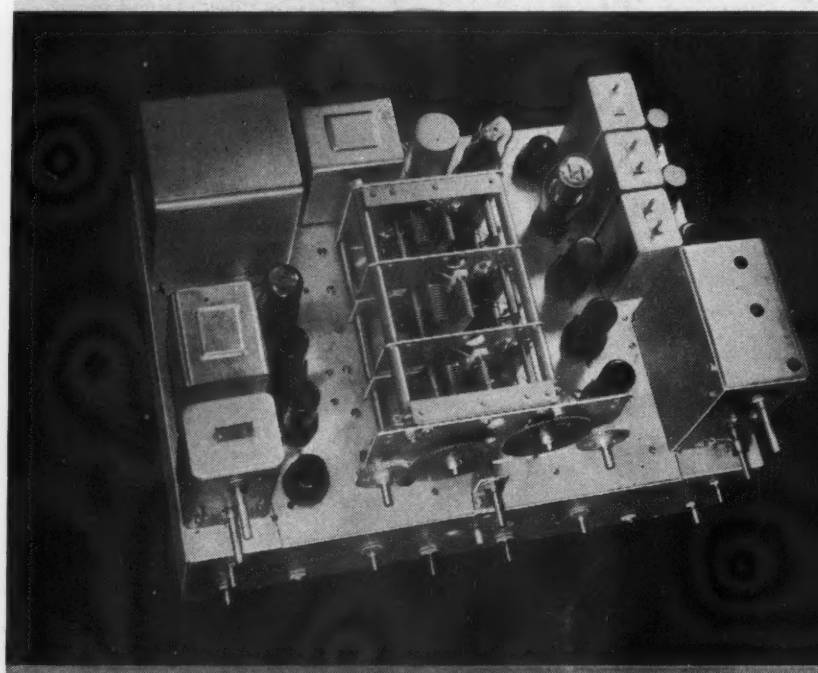
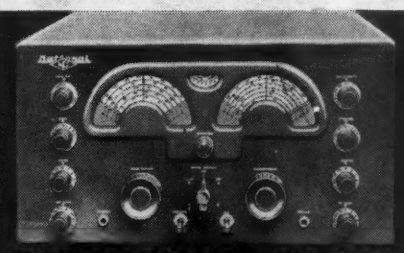
- Ask your dealer to let you see and hear the new moderate-priced NC-173.





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The TECH ENGINEERING NEWS

PROFESSIONAL JOURNAL OF THE UNDERGRADUATES

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COVER

Design and drawing by Miss Katherine Rogers

TITLE PAGE

Dehydrated orange powder is deposited in the suspended flask. The Dewar flasks contain dry-ice alcohol mixture for condensing out the water from the juice. The whole operation is performed under vacuum.

Food Technology Department

MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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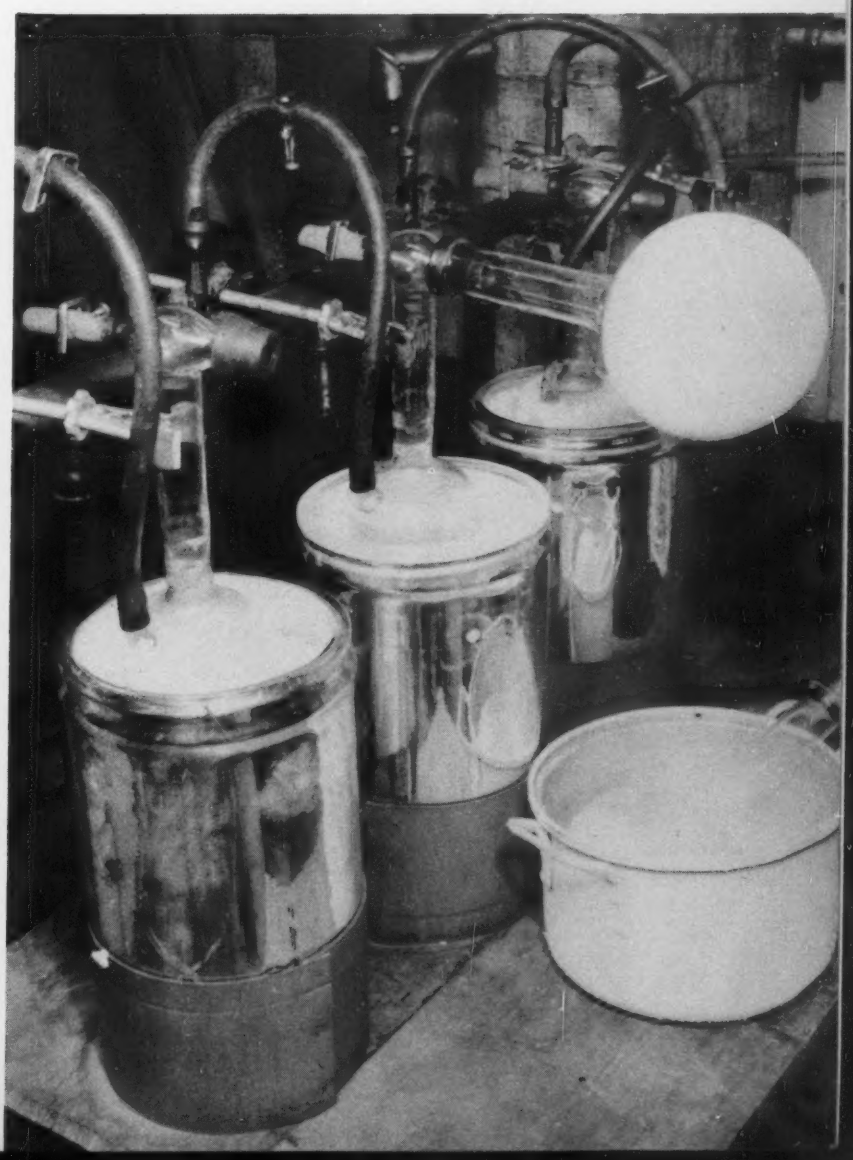


Final check-up of a Chance-Vought fighter before air tests

Official U. S. Navy photograph

Evolution of an Airplane

By FLETCHER EATON, '49

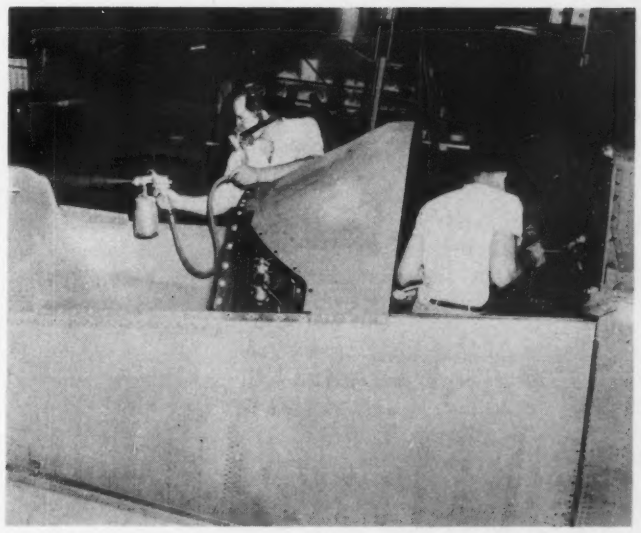
PART II

MODERN airplanes are so complicated that it is often a marvel to many people that they actually fly. Just how the engineer can be certain that his plane *will* fly after it has gone through the complicated process of being manufactured is the subject of this article.

In a previous issue, we discussed the use of a wind tunnel in evolving the external shape of a plane. In the present article we will begin with the premise that the engineer knows what the external shape of his plane is to be. He is satisfied as a result of his wind tunnel tests that the design is sound and he continues his labors without further recourse to the tunnel. His hard won information is recorded full-size on sheets of metal and, in the case of the body lines of his plane, has the appearance of Figure 1. Similar line drawings are available for every major component of the ship. Thus, separate drawings exist for the wing, the vertical tail, the horizontal tail, the gull-like center-section, the engine cowl, the pilot's canopy, and all other external surfaces. (All references are to the Chance Vought "Corsair".) Since the ship is symmetrical about a vertical center plane, it is only necessary to show the lines for one-half of the ship in the figure.

What now happens is this: Each of the lines or contours in Figure 1 is reproduced separately on as many individual steel sheets. Steel is used because fine lines can be drawn on its surface, after it has been painted with a special type of white paint, and it is not affected by atmospheric conditions which would cause many other substances to shrink or swell. To aid in our discussion, we will choose one contour from those in the figure and follow it through the engineering process to see what is done. For our example we have chosen Station 218 on the drawing. (Station numbers indicate the location of a contour on the ship. Station 218, for instance, is located 218 inches, or 18 feet 2 inches, back of the propeller hub.)

The work is now taken in hand by the airplane company's mold loft, so named because in shipyards, which have similar departments, the *mold* lines of the ship's hull are drawn in a *loft* up over the ship ways. The methods of lofting have been adapted to aircraft manufacture and hence the name. The loftsman painstakingly draws every part of the ship occurring at that station. His job is to fit all the necessary components inside the basic contour. Since this contour is coordinated with every other through the medium of Figure 1, everything the loftsman draws will fit inside the airplane when it is put together on the assembly line. His finished drawing is shown in Figure 2.

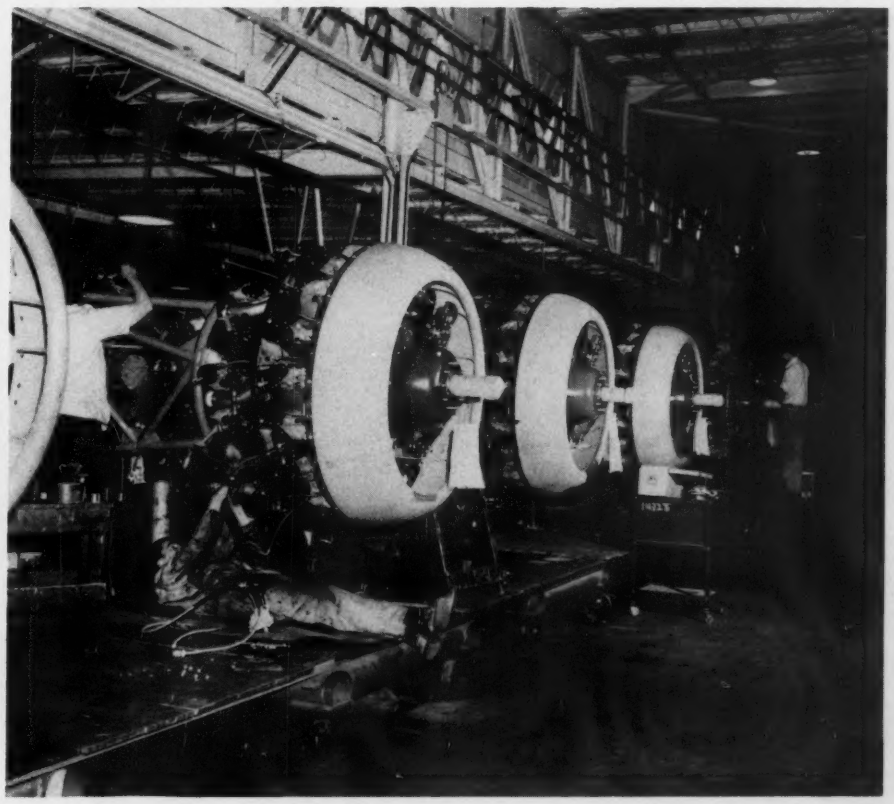


United Aircraft Corporation

The forward section, with tail section joined, now starts out on its way down the final assembly line. The man at the left is spraying paint on a section that will later be enclosed. The workman at the right is checking cockpit installations.

An assembly line for fighter engines

United Aircraft Corporation



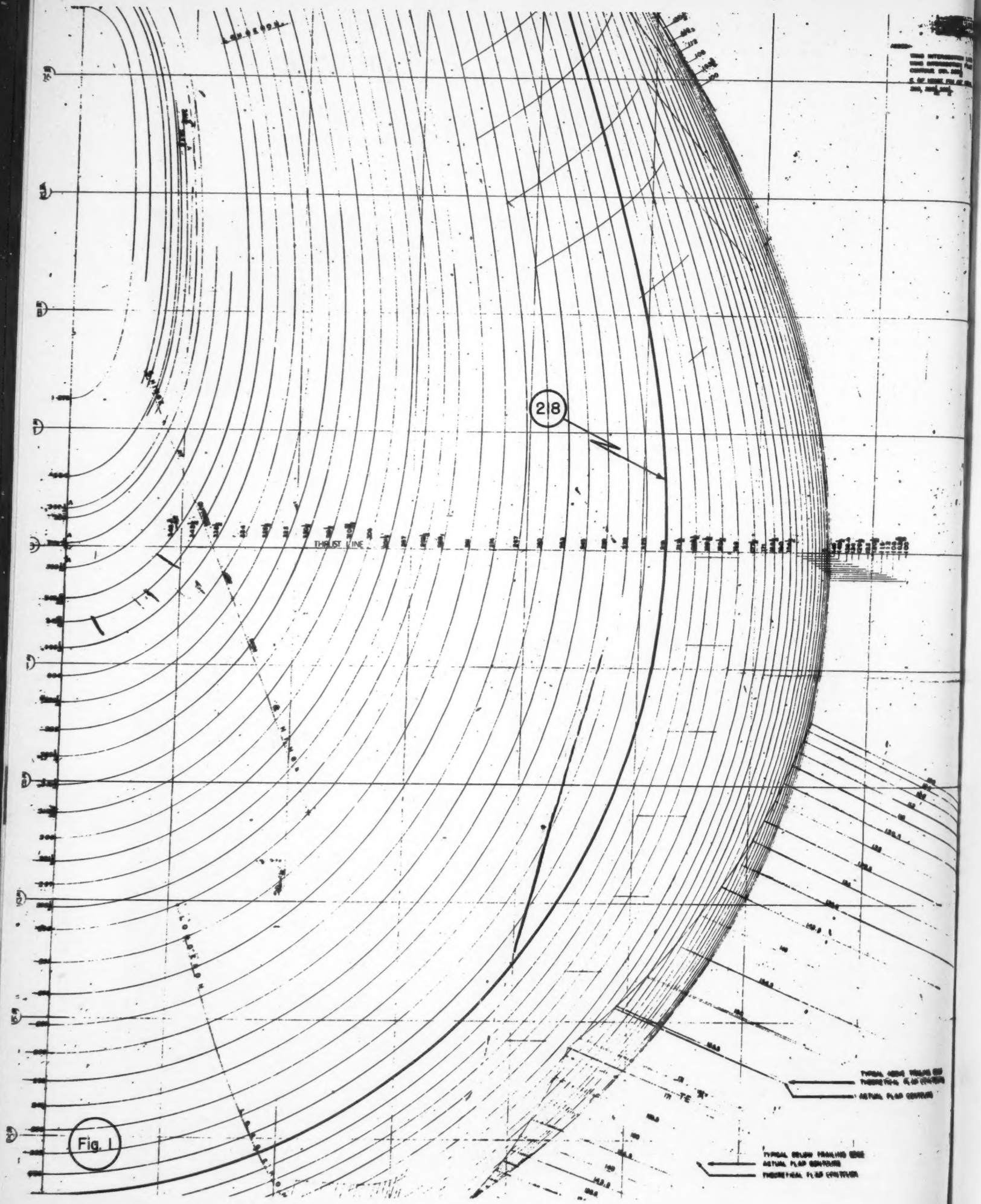
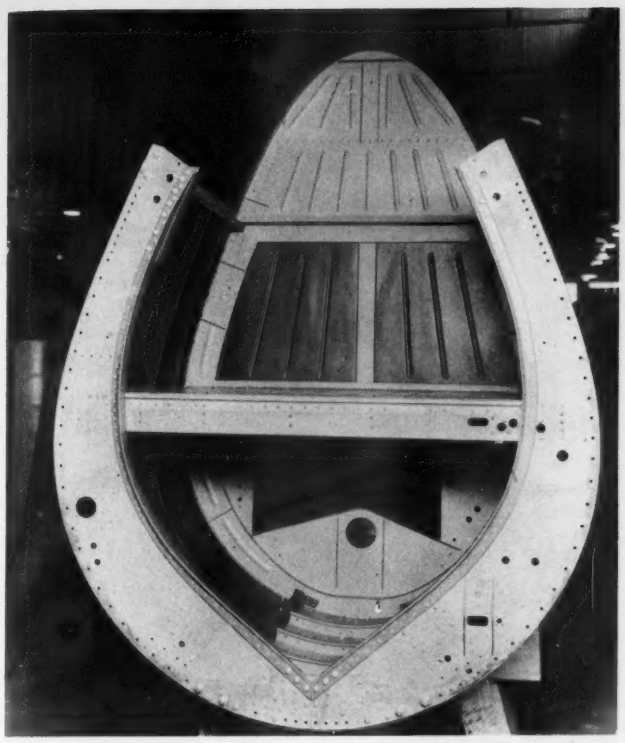

218
THRUST LINE
TYPICAL AIRFOIL TRAILING EDGE
THEORETICAL FLAP CONTOUR
ACTUAL FLAP CONTOUR
TYPICAL AIRFOIL TRAILING EDGE
ACTUAL FLAP CONTOUR
THEORETICAL FLAP CONTOUR

Fig. 1



Vought-Sikorsky Aircraft

View looking aft at station 218 with the bulkhead at station 186 in the foreground

We now have an accurate full-size picture of one specific part of the ship. On it are shown all the brackets, angles, channels, etc., which are necessary to hold the ship together at this location. Not only are these parts shown but so also are the rivet and bolt holes which hold them together. These are actually drilled into the layout. From this point on, the layout serves as a constant guide in the making of all the tools necessary for fabrication of the parts shown.

Templates are now made and carefully fitted to the layout. In principle, they resemble the patterns used in dressmaking. One type of template shows the flat pattern of the part to which it relates. This type also includes all the holes which will later be drilled in the part. Other templates give the shape of the form blocks over which the flat sheets of aircraft metal will later be bent. The general idea behind the template is that it enables men in the machine shop to make accurate tools without having to refer constantly to the master layout shown in Figure 2.

The next step in the process is the actual cutting out of the flat sheet metal parts. In one method, sheets of aluminum of the proper thickness are stacked on a table from ten to fifty at a time depending on the number of parts needed and also the thickness of the pile. The flat-pattern template is then laid atop the pile and firmly located. A profiling cutter is guided around the pile trimming the entire stack of sheets to the exact shape of the template on top. Any rivet or bolt holes appearing in the template are subsequently drilled directly through the template.

A second method of cutting the flat sheet metal parts is to blank them or punch them in a press. This can only be done for small pieces due to the expense of the dies.

Check-up on the hydraulic system of a fighter plane

United Aircraft Corporation

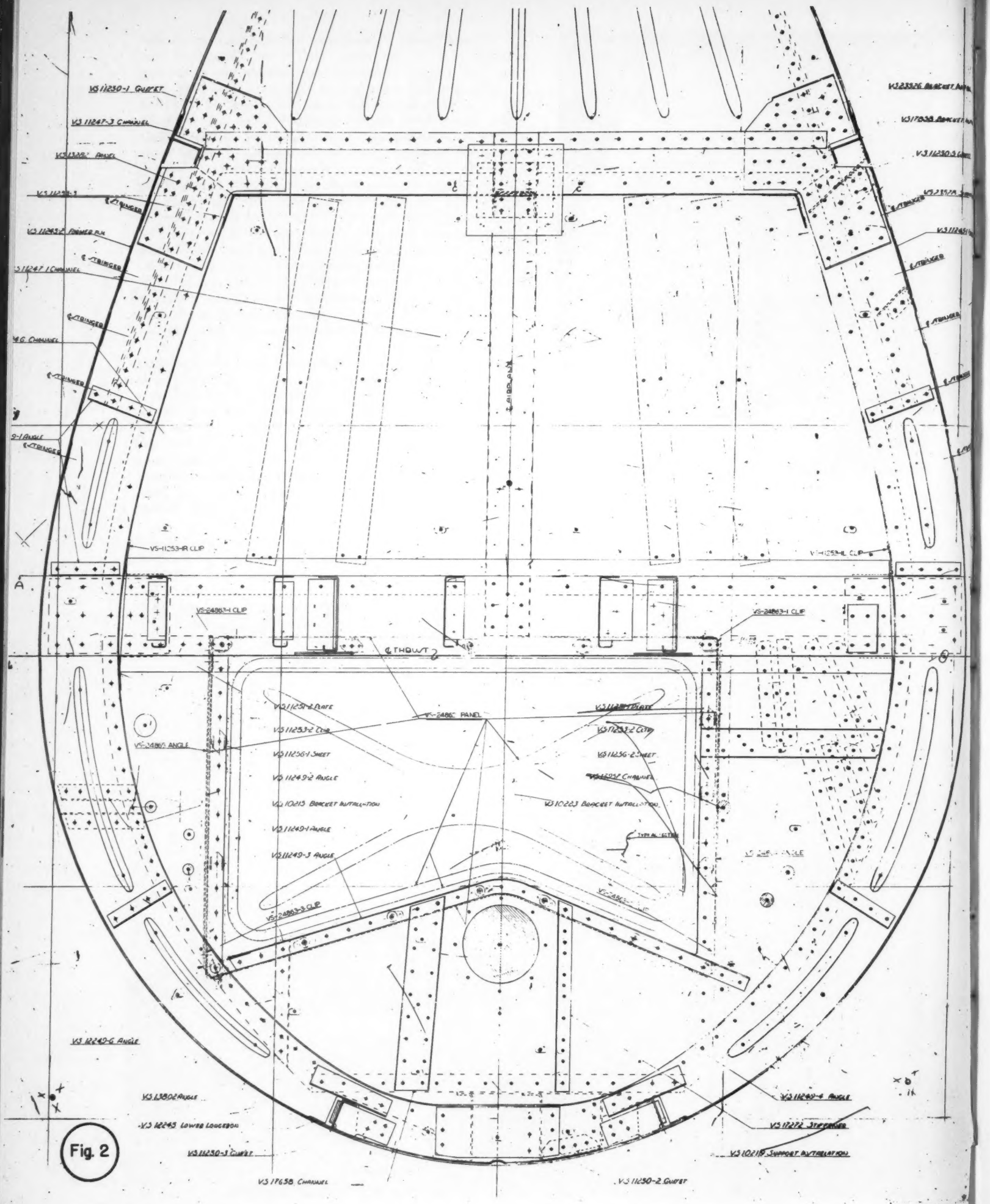
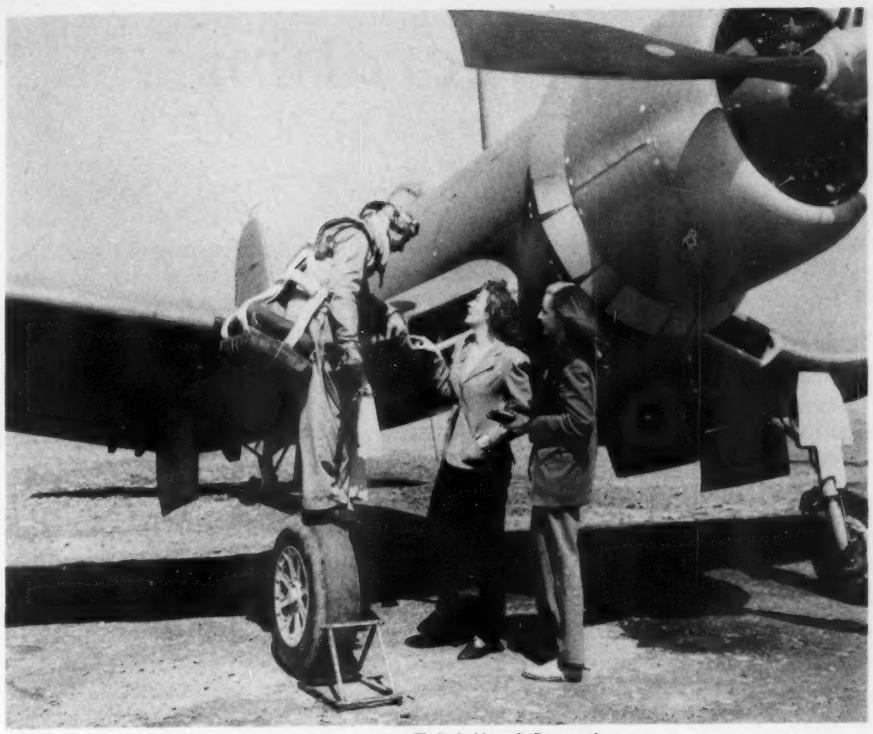

VS 11230-1 GUSSET
VS 11247-3 CHANNEL
VS 11230-3
VS 11243-2 INNER PLN
VS 11247-1 CHANNEL
4 G. CHANNEL
9-1 ANGLE
VS-11253-HR CLIP
VS-11253-HL CLIP
VS-24863-H CLIP
VS-24863-I CLIP
VS-24865 ANGLE
VS 11253-2 CLIP
VS 11256-1 SHEET
VS 11249-2 ANGLE
VS 10213 BRACKET INSTALLATION
VS 11249-1 ANGLE
VS 11249-3 ANGLE
VS-24863-3 CLIP
VS 11253-2 CLIP
VS 11256-2 SHEET
VS 10223 BRACKET INSTALLATION
VS 11249-6 ANGLE
VS 13802 ANGLE
VS 12243 LOWER LOCATION
VS 11230-3 GUSSET
VS 17658 CHANNEL
VS 11250-2 GUSSET
VS 11249-4 ANGLE
VS 17272 STIFFENER
VS 10218 SUPPORT INSTALLATION

Fig. 2

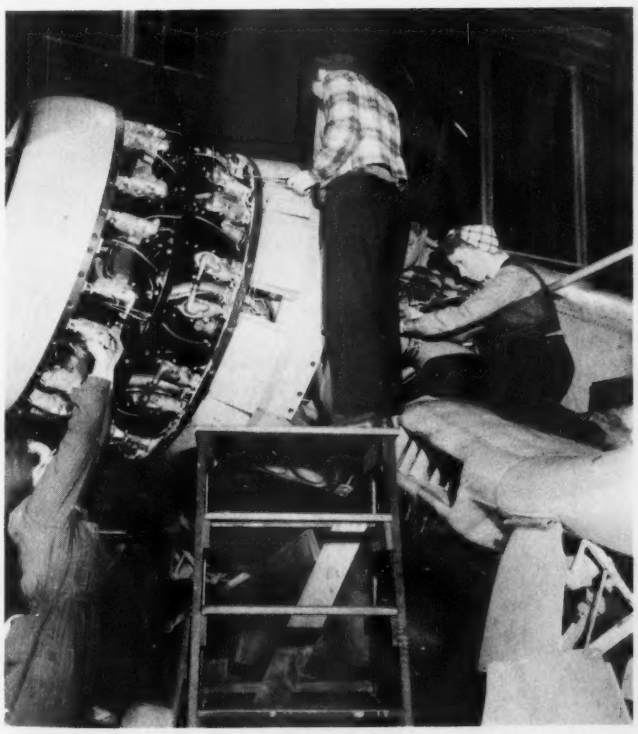


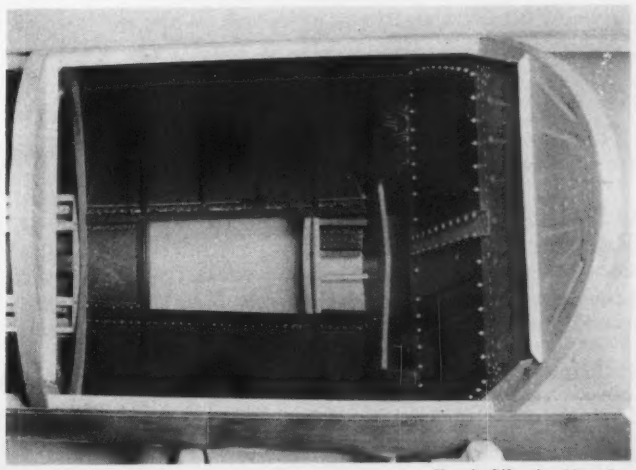
United Aircraft Corporation

Female engineering students at Chance Vought Division of United Aircraft are not dependent on textbooks for all of their knowledge. Here two would-be engineers are acquiring first-hand information on flying characteristics from test pilot Bill Horan

The sheet metal parts which we have followed through the profiling and drilling process are now taken to huge presses to be formed. This process is rather spectacular since the machines involved stand as much as thirty feet high and are so obviously powerful as to cause the onlooker to beware. Essentially, a press consists of a huge piston operating within a cylinder mounted above a steel table. The lower end of the piston is covered with a thick block of rubber which flows around any object on the table when the piston is forced down. Since the rubber is about the same consistency as that in the tread of an automobile tire it is clear, at least to an actual observer, that tremendous pressures are required to make it flow. Our sheet metal parts are now located on the steel table beneath the piston. Each part is mounted on a form block by means of pins. The crushing force of the enveloping rubber causes the sheet metal to be bent down over the form block to which it is attached and when the piston is returned to its upward location again, the completed part is left on the table below. A few operations such as heat treatment and the straightening of minor bends remain but the part is nearly finished when it leaves the press.

A group of busy workmen put the finishing touches on a fighter plane United Aircraft Corp.





Vought-Sikorsky Aircraft

Bulkhead at station 218 is shown at the right. Compare this photograph with Figure 2

With the completion of the cutting and forming of the sheet metal parts necessary to make the bulkhead at Station 218, the next step is one of sub-assembly. Since all holes have been previously drilled, this step is quite simple. It involves pinning the parts together and then riveting them. A coat of corrosion-proofing chemical is applied to the entire bulkhead and it is then shipped to a storage depot ready for use as a major component in a new plane.

Essentially the same story could be told about every part in a modern all-metal airplane. What we have tried to emphasize here is that there is nothing really amazing about the fact that the first airplane off a modern assembly line will fly. After all, it is merely a large copy of a design whose satisfactory performance was demonstrated in the wind-tunnel many months before.

Heating by Refrigeration

By RICHARD W. SPENCER, '49

WHEN a substance is carried through a reversible thermodynamic process as represented in the curve *abc* in Figure 1, an amount of work

$$W = \int_{V_a}^{V_c} PdV$$

is performed by the substance. This integral is equal to the area under the curve (shown shaded in Figure 1).

Now, referring to Figure 2, let us return the substance to its initial state *a* by way of process *cda*. An amount of work equal to the area under this curve must be done on the substance. Thus, the net amount of work done by the substance going through the cyclic process *abcda* is equal to the shaded area enclosed by the curve.

Of course, energy must be supplied in the form of heat to cause this process to take place. The net heat Q supplied in a reversible process is equal to the change in internal energy of the substance, ΔU, plus the work W done by the substance. In one complete cycle there is no net change in internal energy, as the substance is returned to its initial state. Therefore, the net heat supplied during a complete cycle equals the work done. Expressing these statements as equations, we have

$$\begin{aligned} Q &= \Delta U + W, \\ \Delta U &= O, \\ Q &= W \end{aligned}$$

for a reversible cycle.

I was careful to specify that Q was the *net* amount of heat supplied. The reason will be pointed out below. Referring to Figure 3, consider a cycle composed of two isothermal processes *ab* and *cd* and two adiabatic processes *bc* and *da*. Such a cycle is called a Carnot cycle, and is the most efficient possible cycle between any two given extremes of temperature, T_1 and T_2. Figure 3 represents a Carnot cycle for a gas, but the following discussion is valid for any substance, in any phase (gas, liquid, or solid).

Figure 4 represents the same Carnot cycle as Figure 3, but is expressed in terms of a different pair of coördinates. The area enclosed by the cycle equals

$$\int_{S_a}^{S_b} T_2 dS + \int_{S_b}^{S_a} T_1 dS = Q_2 - Q_1$$

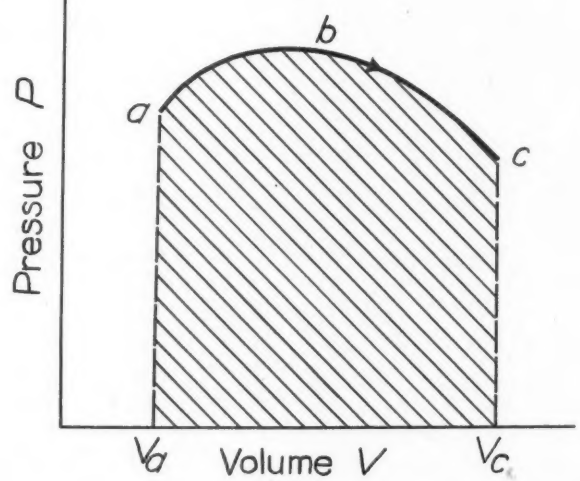
where Q_2 is the amount of heat which must be supplied at temperature T_2 to carry the process from *a* to *b*, and Q_1 is the heat rejected in the portion of the cycle from *c* to *d* at temperature T_1, generally too low a temperature to be useful as a source of energy. The efficiency of a Carnot cycle is

$$\eta = \frac{W}{Q_2}$$

or

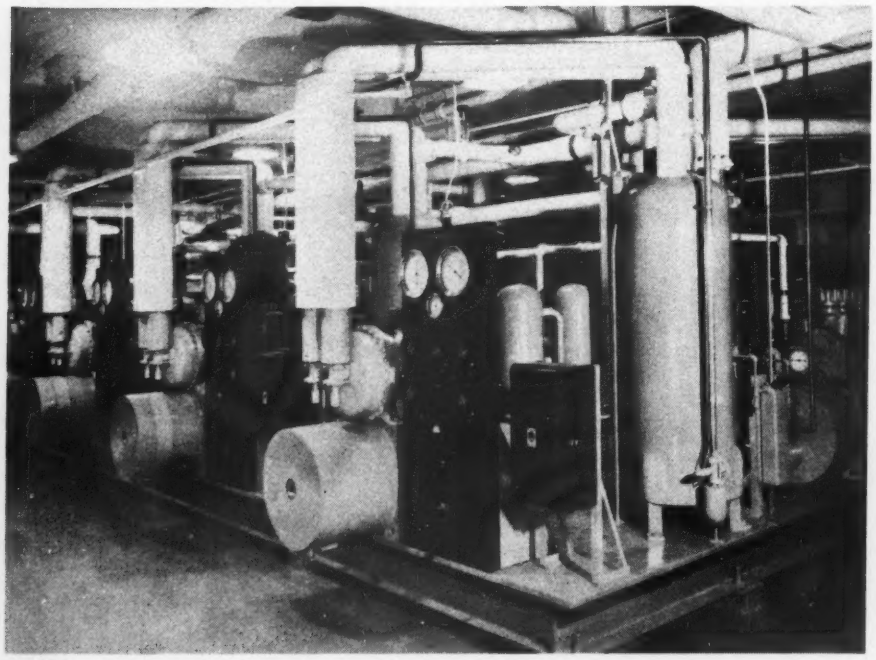
$$\frac{T_2 - T_1}{T_2}.$$

FIG. 1



Refrigeration equipment consists of eight completely independent condensing units, mounted in two rows of four machines on a single structural steel sub-base

Power Magazine



The discussion so far has been concerned with an engine to convert heat at a high temperature to mechanical work, with the incidental loss of heat at a lower temperature. The cycle can be operated in reverse. Mechanical work is supplied, and heat at a lower temperature is delivered at a higher temperature. The refrigerator is a common example. Its purpose is to deliver heat from inside (at a low temperature) to the atmosphere outside (at a higher temperature). This process is represented in Fig-

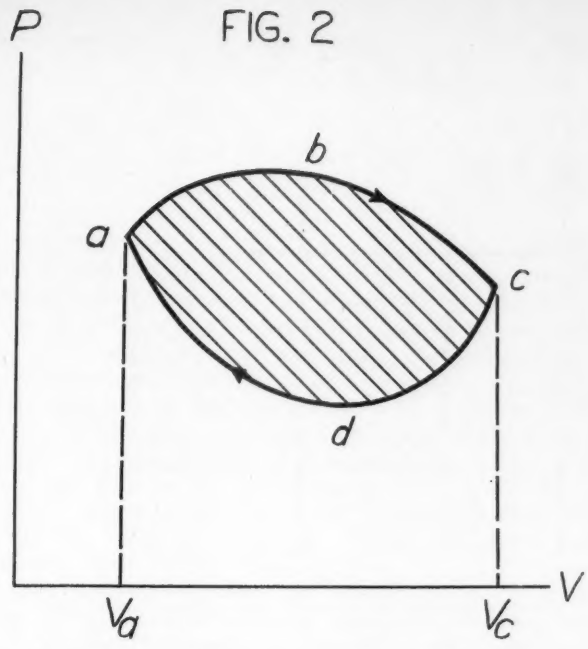


FIG. 2

ure 5, which is nothing more than the cycle of Figures 3 and 4 operated in reverse. A measure of its efficiency as a refrigerator, the coefficient of performance, is

$$\text{C.O.P.} = \frac{Q_1}{W} = \frac{Q_1}{Q} = \frac{T_1}{T_2 - T_1}.$$

This apparatus can be used as a heater as well as a refrigerator, where Q_2 is the heat desired, the useful heat for building heating purposes, for example. In this case

$$\text{C.O.P.} = \frac{Q_2}{W} = \frac{Q_2}{Q} = \frac{T_2}{T_2 - T_1}.$$

The C.O.P. of such a heater can be greater than unity, as can be seen. This means that a kilowatt-hour of electrical energy, for example, can introduce more than one kilowatt-hour of useful heat into a building. Use is made of this fact in the so-called heat pump, which will now be described.

An electric motor drives a compressor which compresses and liquefies a gas in the coils of a heat interchanger in the house heating system. After giving up heat in the house it passes through an expansion valve and into the coils of another heat interchanger at the source of heat — the outdoor air, a reservoir of water, or simply the earth — where it vaporizes and expands, returning to the compressor to repeat the process. With a temperature of 40° F. at the source and delivering at 100° F. to the heating system of the house, the theoretical C.O.P. is 9.33. An actual C.O.P. of about 5 has been realized in actual installations under similar conditions.

An advantage of the reverse cycle system is that it can be operated to "pump" heat out of a building as well as into it. Thus, it can be used, in connection with air-conditioning equipment, to cool in summer as well as to heat in winter.

So far, the picture sounds attractive. However, this system has serious drawbacks. If the system utilizes

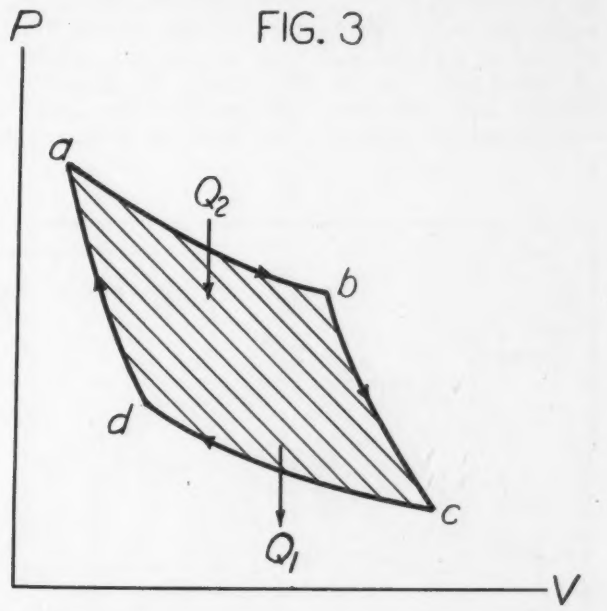


FIG. 3

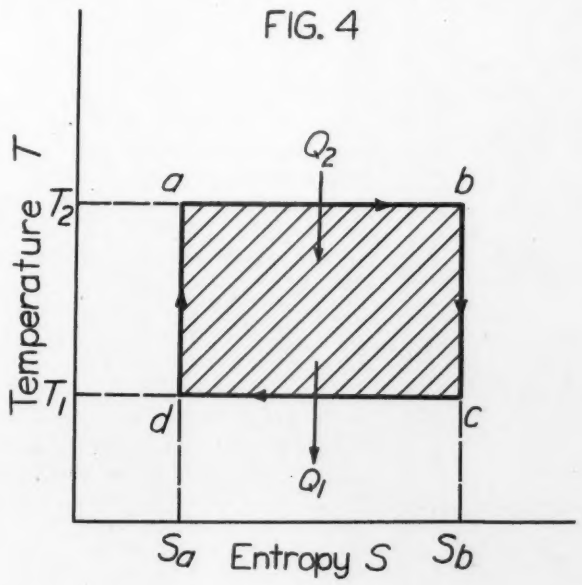


FIG. 4

the outside air as a source of heat, the source will be coldest at the very times the most heat is needed. This means that a reverse-cycle system capable of heating a given building in zero or sub-zero weather must be a much larger installation than is necessary in more moderate weather. Also, dew or frost on the evaporator coils seriously decreases the efficiency of the apparatus. This would be a source of constant trouble in many climates. The system shows greatest promise in a mild climate without too much variation of temperature, in a locality where the heating load in winter will be approximately equal to the summer cooling load.

Some of the systems in use utilize well water as a source of heat. This is likely to be at nearly constant temperature, and therefore is a good heat source for the purpose, but relatively few buildings are situated in places where this use of wells is feasible.

Some small units for heating a single room or a few rooms use the earth as their heat source. As earth is a rather poor conductor of heat, and is unable to flow around the evaporator coils as a fluid can, this arrangement requires quite an extensive system of underground piping in order to have enough surface to supply much heat. For this reason the ground will probably never be used extensively for heating large buildings.

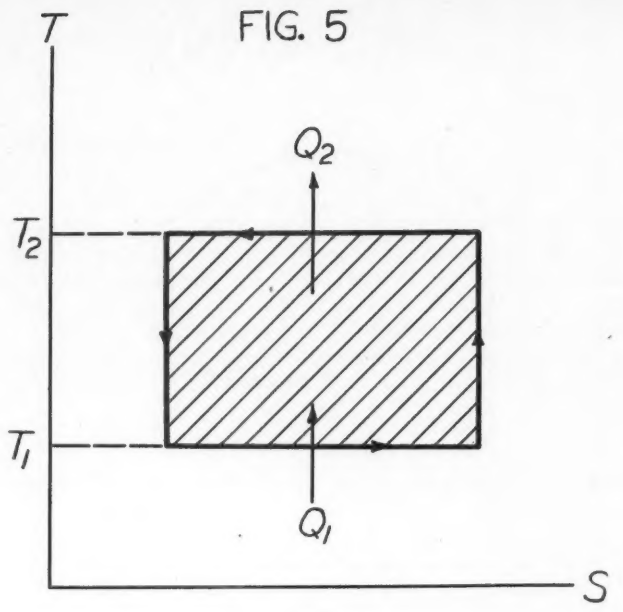
One of the few large installations, if not the only one, in an area subject to severe winter weather conditions is the installation in the Administration Building

of the United Illuminating Company in New Haven, Connecticut. This equipment is designed to meet all heating requirements for outside temperatures down to 20° F. Auxiliary heating is provided to help out in colder weather. The system also cools the building in summer. Its heat source consists of well water which remains at a constant temperature of 55° F. the year round.

While under ideal conditions this type of heating might compete with conventional methods, the initial cost and difficulties of design often make its use impracticable. For example, the cost of an installation to heat a six-room house, the equipment to be assembled by the contractor, was once estimated at about $2600, as compared with $700 for a warm air heater or $1650 for a furnace and air-conditioning system.

An installation in Pittsburgh, Pennsylvania, assembled from standard equipment, and using outdoor air as a source, gave an operating cost, at $.01 per kwh., equivalent to the cost of heating by coal at $14 per ton, oil at $.10 per gallon, or natural gas at $.80 per thousand cubic feet. In this country the savings to be realized have not been sufficient to bring about the widespread use of the system. There are perhaps thirty

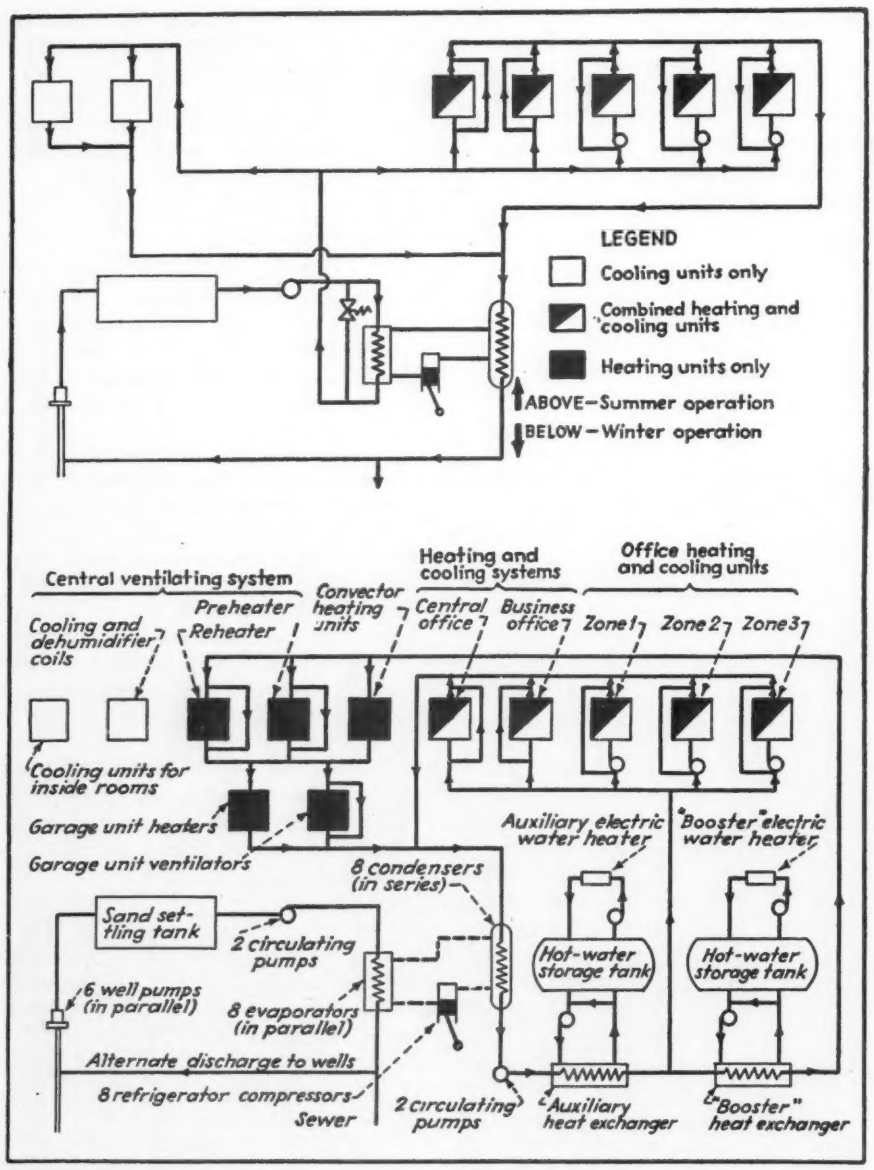
FIG. 5



or forty reverse-cycle heating installations in use in the United States, many of which could properly be called experimental in nature. A few compact, enclosed unit heaters for small loads have been made, but nearly all the larger installations arecomposed of standard parts — compressors, evaporators, etc. — designed for other uses.

Switzerland has been a leader in the adoption of this method of heating, due largely to the scarcity and high cost of coal and other fuels, and the low relative cost of electric power.

As long as the cost of operation of a reverse-cycle system in this country is nearly equal to (or greater than) that of heating by conventional methods, its use will obviously not become widespread. The development of this method of heating is at present being pushed by the electric power industry, as its widespread use would greatly increase electric power consumption. It is conceivable, therefore, that with much increased use of this system, electric power could be sold at a price which would enable the reverse-cycle method to compete successfully with other methods of heating.



A simplified diagram shows winter and summer operation

Power Magazine

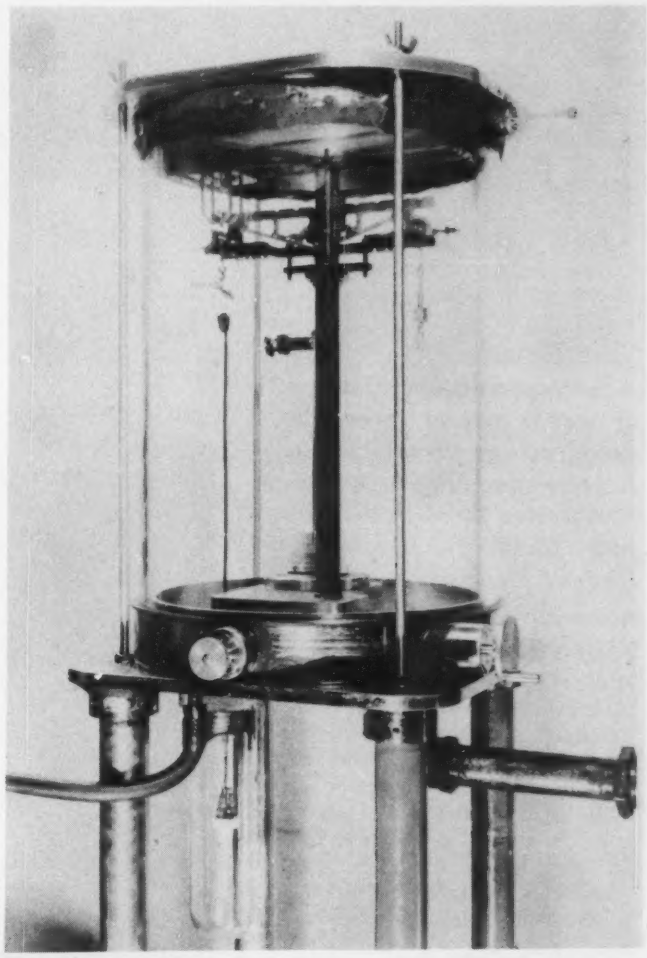
Food Technology

By *LEO SARTORI, '50*

FOOD Technology, the newest department at the Institute, offers a course which deals with the applications of chemistry, biology, and physics to the diversified needs of the food industries. In recent times, the food industries have experienced a marked trend towards the employment of more extensive technological methods and scientific research on a greater scale. Consequently there has arisen a substantial demand for men trained in the basic sciences, especially chemistry and biology, and in the methods of application of these sciences to food research, production, and distribution. M. I. T. is one of the few colleges in the country which offers such a course.

A student in Course XX obtains in his first few years a firm background in the basic sciences just mentioned. The four years of chemistry which he takes include organic, physical, and biochemistry, and actually comprise more credits than chemistry majors take in many other colleges. Three years of biology give a sound knowledge of that science, and, besides two years each of physics and math, various other courses are taken in chemical engineering, business administration, etc. With this general background and the actual experience in Food Technology which is gained in the latter years of the course, the graduate is well equipped to meet almost any problem which might arise in the food industry. Further graduate study then enables one to enter the research field.

The problems of the food industry to which technological methods can be applied are manifold. They concern mainly the growth, composition, and flavor of foods, and the effects on flavor and nutritive value of various conditions which might be imposed, such as temperature, packaging, age, etc. Also involved are the operation of food plants, and the application to practical use of the new techniques developed in the laboratory.



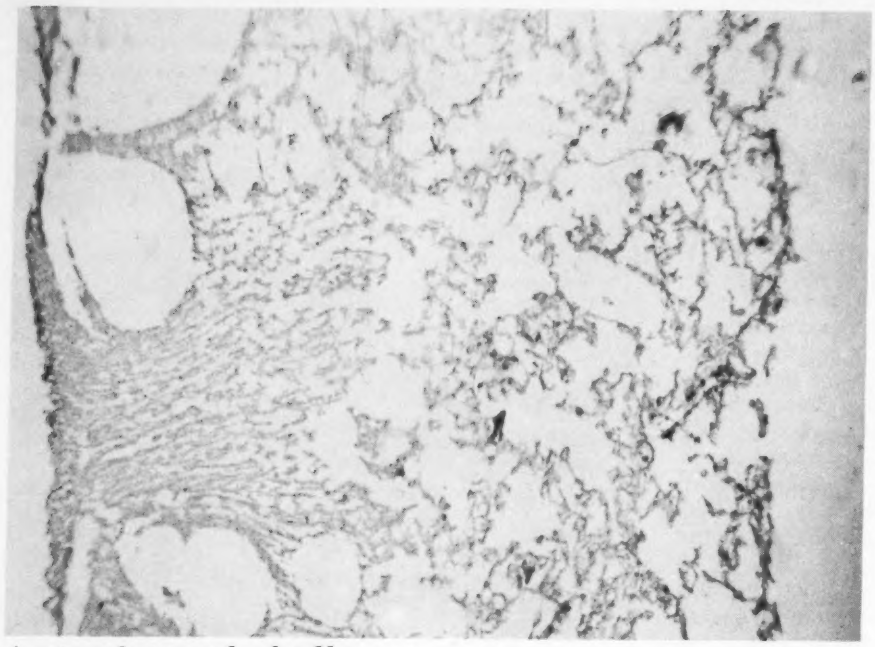
A laboratory experiment in high vacuum dehydration of foods. This particular apparatus is arranged so that the vapor pressure of water above the food component may be measured

Food Technology Department

Food Technology Department

A chainomatic balance which operates in a sealed jar under a vacuum of nine microns of mercury. It is used for weighing products sensitive to atmospheric oxygen or moisture

Perhaps the most important single problem in food technology is the determination of the chemical composition of foods. For, if the composition of a substance is known, then its food value can also be determined, and the proper methods of treatment and improvement can be



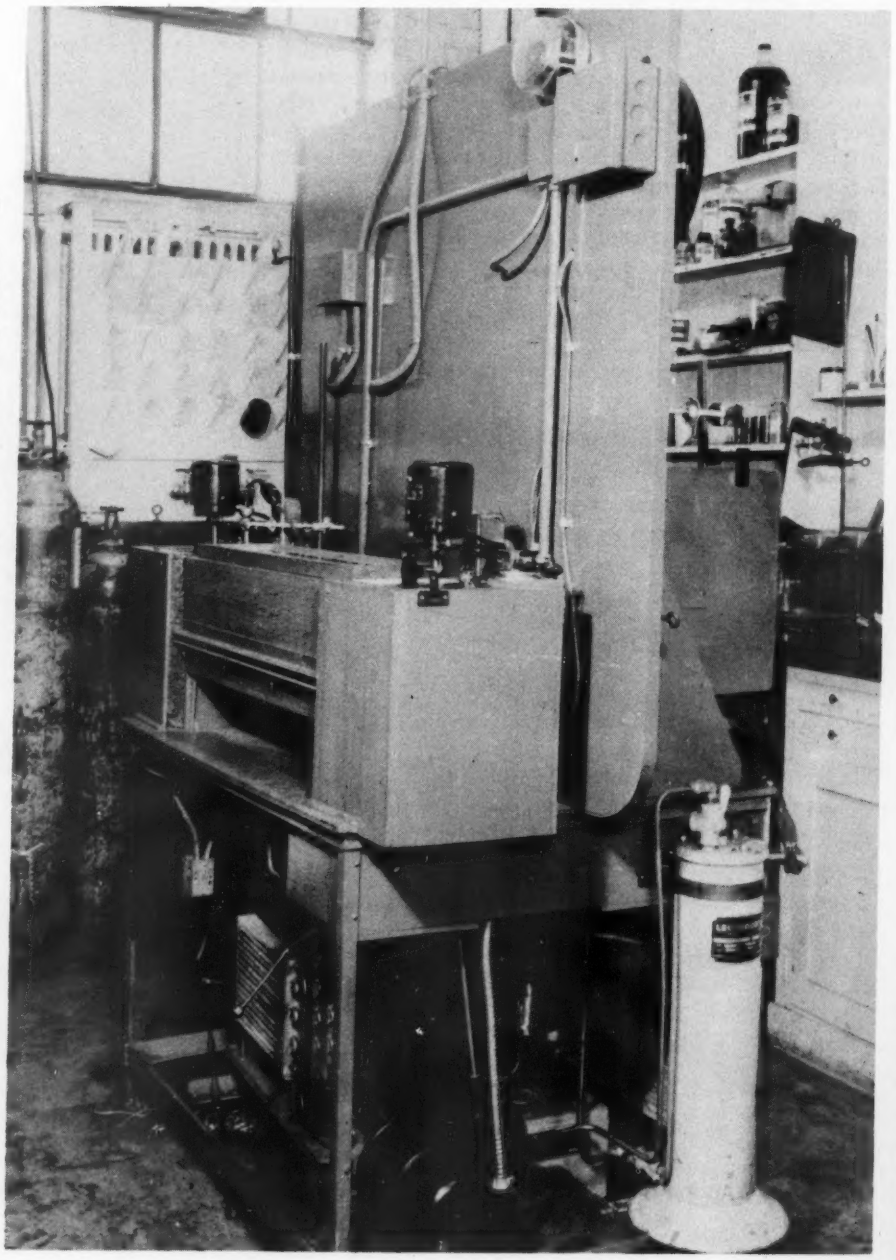
A microphotograph of a film of orange powder formed by dehydrating a spray of orange juice under high vacuum. The section through the film indicates that the powder has a semi-fibrous structure

Food Technology Department

applied to it. Whenever a new substance is suspected of possessing hitherto unknown value as a food, extensive chemical tests must be performed on it to determine its true composition. As a matter of fact, samples of foods from all parts of the country and from places as far away as South America and China are constantly being received by the food laboratories here for analysis. The subject of organic chemistry is of course of the utmost importance in this type of work, especially in the analysis of substances such as proteins, carbohydrates, and vitamins, which are the main sources of food value. The food technologist is needed because of his knowledge of the chemistry and biology of food.

Flavor is another major field with which the food technologist is concerned. Companies are always interested in improving the flavor of their products, since it is the one way in which the public is capable of judging a food. Consequently, there is taking place continuous research in the testing and improvement of flavor, and much of this sort of work is taking place in laboratories here at the Institute. The question of just what substance or substances in the food is responsible for causing the flavor is one which has not been completely answered, and upon which much research is being conducted. Of perhaps more practical value is the effect on flavor (and on nutritive value) of such

(*Continued on page 290*)



Within the box in the center is a very thick copper bar which is heated at one end and cooled at the other. This sets up a gradient of temperature within the bar which is easily measurable. By dropping various food preparations on the bar, the sticking point can be measured. This property is a very important one in the food processing industries as it determines the highest temperature that may be applied to any given food material

Food Technology Department

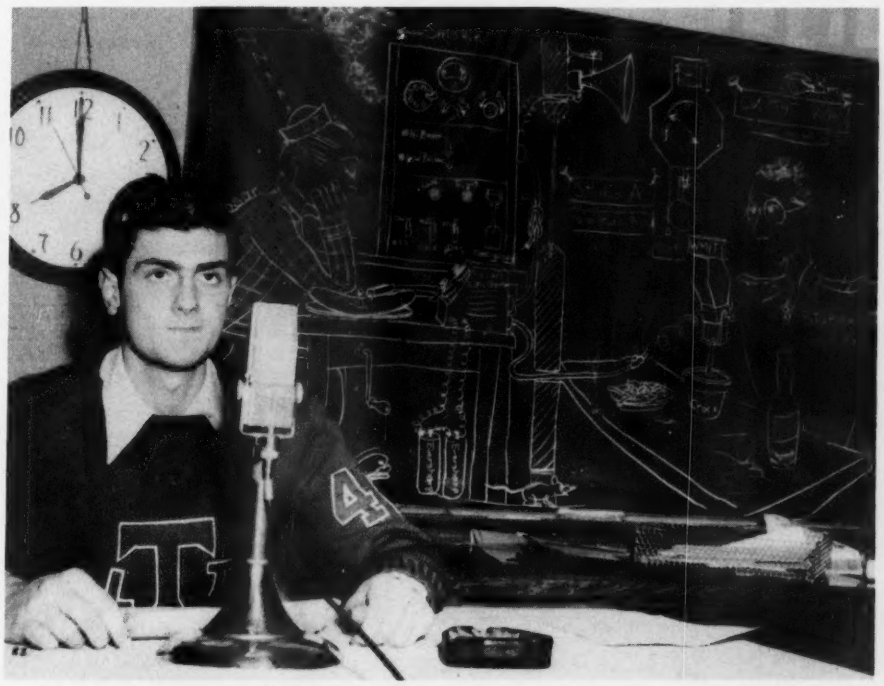
WMIT—The Beaver Network

By WMIT STAFF

A NEW student activity was launched at 8 p.m. on November 25, 1946, when Dr. Karl T. Compton made the inaugural address at the opening of the Institute's carrier-current broadcasting station, WMIT. With headquarters, studio, and control room in Ware Dormitory, the station provides regular programs to the dormitory students during the school year.

WMIT operates on the carrier-current principle in which the 110-volt power lines act as the medium for transmitting the programs. The distance over which signals may be picked up does not extend beyond 20 to 30 feet from the power lines to which the transmitter is coupled. The range is, consequently, so small that no license is required and the activity does not come under the jurisdiction of the Federal Communications Commission.

Within the service area of the station which now includes the undergraduate dormitories, Walker Memorial, and the President's House, programs may be received on any radio frequency receiver tuned to the station's frequency of 800 kilocycles per second.



H. Koerner

In five seconds, at 8:00:00, the announcer will begin another evening of broadcasting over WMIT with the now-familiar words, "It's eight o'clock and Station WMIT resumes its broadcasting activities. . . ." Several of the station "artists" collaborated to produce the "art" on the blackboard

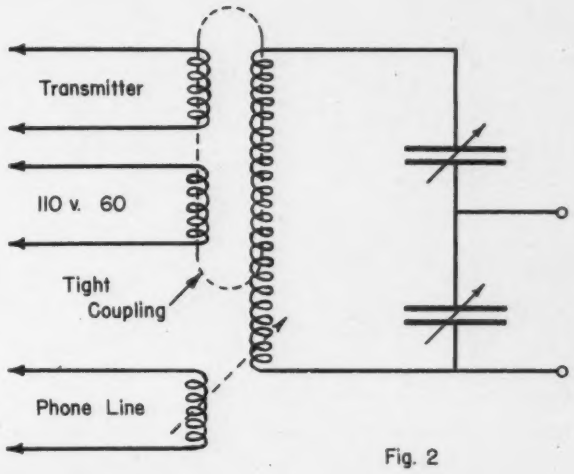


Fig. 2

WMIT was organized early in October, 1946 by a group of students including Richard Baum, Albert J. Davidson, Paul F. Ely, Jr., Harold Jacobson, Henry Koerner, Harold B. Nelson, Jack C. Page, and Michael T. Rosar. Together they pooled financial resources and purchased the items necessary to build the transmitter. Grants from the Institute Committee, the Dormitory Committee, and the Institute administration have made possible the repayment of these loans.

The station is operated on a businesslike basis similar to that of commercial broadcasting stations. A constitution was drafted for the student government of the station and was approved by the Institute Committee. Applications for student participation were distributed and those interested were assigned to positions in the engineering, program production, advertising, and business departments.

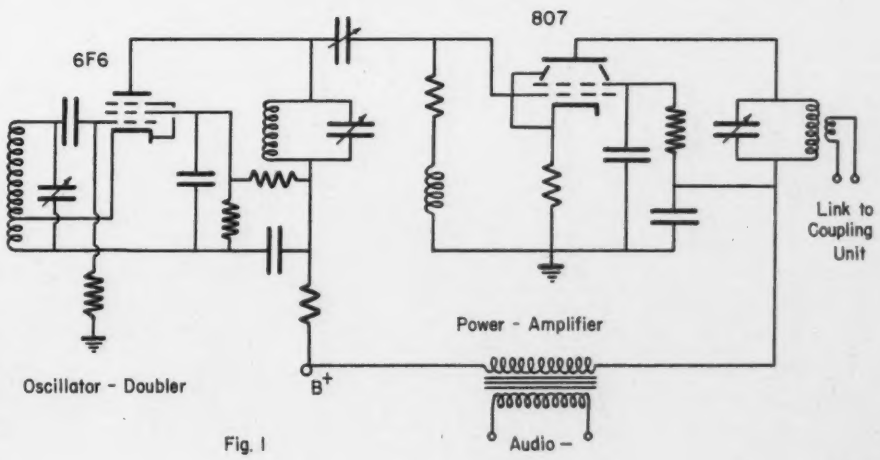


Fig. 1

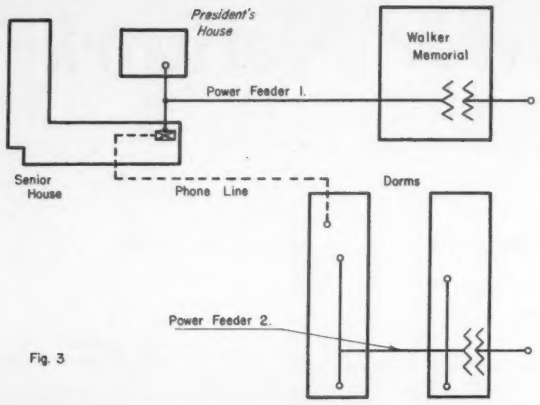


Fig. 3

H. Koerner

The engineer studies the program sheet for the classical music program which follows the "pops" presentation now on the air. In front of the engineer is the control console. The left-hand set of dials controls the turntable hookup, and the right-hand set determines whether or not the two microphones are "live"

A poll taken by the business department of students living in the dormitories showed that the largest percentage of students preferred classical music, with popular music, news of campus activities, lectures, debates, and sports following in that order. In accordance with the results of that poll the station is operated each week-day evening between 8 p.m. and 12 midnight. In addition to these hours, dance music is broadcast from 12 midnight to 2 a.m. Saturday and Sunday mornings.

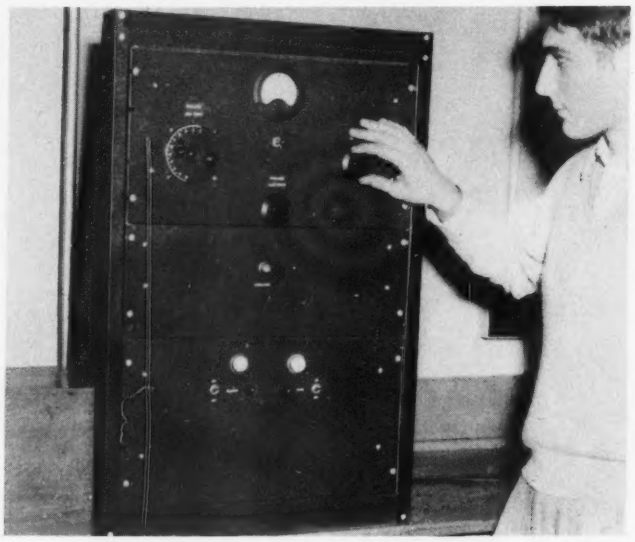
The transmitter used by WMIT has a power output of about 20 watts depending upon the load conditions. It consists of an electron-coupled 6F6 oscillator doubler followed by an 807 power amplifier, plate modulated. See Figure 1 for the circuit diagram.

The R.F. power is fed through a link from the power amplifier tank circuit to a tuned resonant coupling circuit which provides for several outputs at different voltage and impedance levels. The links to transmitter and to the 110-volt power line are tightly coupled to the coil of the tuned circuit as illustrated in Figure 2. The telephone line which is the transmission line between the transmitter in the Senior House and the New and Old Dormitories is loosely coupled to the coil. This coupling is variable so that the R.F. voltage on the telephone line may be adjusted to prevent overloading of the line. A third output is available through the two series capacitors.

The R.F. signal at 800 kilocycles will not pass through the step-down transformers in the power feeders; hence it is necessary to connect the transmitter to each power distribution area by means of transmission lines. For example the Senior House, Walker Memorial and the President's House are connected to one power feeder, while the New and Old Dorms are on another, Figure 3. In the first area the R.F. signal is strong, since the transmitter is located there and it is possible to couple it directly to the line. Most of the power output of the transmitter is absorbed in this area. This quantity of power is not necessary for good reception, but it is done mainly to provide a load for the transmitter to improve stability and modulation quality. Despite the fact that power is distributed in a three-phase system it has been found that coupling to only one of these phases is sufficient.

The transmission line between the Senior House and the other dormitories across Ames Street is a telephone line of the dormitory interphone system. About 20 volts

(*Continued on page 306*)



K. Koerner

At ten minutes of eight, the engineer in charge flicks the switch, warming up the transmitter that sends WMIT out to its listeners

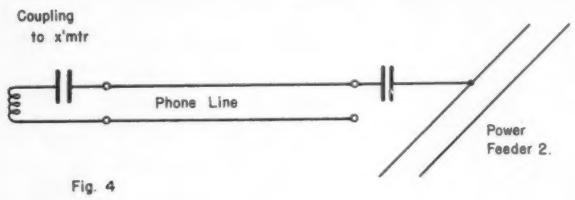


Fig. 4

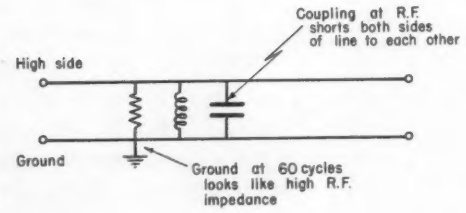


Fig. 5

"THE GREATER LIGHT TO RULE THE DAY . . ."

Seventh in a series of articles on Elementary Astronomy

By PETER B. NEIMAN, '49

"FROM this earth of ours the astronomer's brain intelligence can reach out across 93,000,000 miles of space and determine what the sun is made of, what its temperature is, what the conditions are in the solar atmosphere, and acquire this information with so much of certainty that we know more of conditions in the solar atmosphere than we do of the terrestrial." — *Dr. S. A. Mitchell.*

Perhaps the best way of presenting a clear and systematic description of the sun is to fall back on the over-used, much-abused, corny, hackneyed, illogical and impossible idea of taking a rocket to the sun. In spite of these handicaps, the idea remains a good one. Okay, kiddies — all aboard for the sun!

The first thing we notice about the sun is that it enables us to walk into the rocket alive, for it is the direct source of the maintenance of all organic processes and is indirectly responsible for all inorganic processes. With the insignificant exception of volcanoes and geysers, it is the source of all power on earth.

From the earth's surface, the sun appears to be a round luminous disk, subtending an angle of 1920″ across its diameter. Since the mean orbital velocity of the earth can be measured by noticing its displacement, or parallax, against a background of stars, and since this method is independent of measurements of the sun, astronomers can accurately measure the radius of the earth's orbit, and from this and the angular diameter of the sun, can also determine its true diameter. Most recent figures have placed the earth at 93,005,000 miles from the sun, thereby giving it a diameter of 866,000 miles. From this figure, simple calculations give the sun a volume of 1,300,000 and a mass of 333,000 times that of the earth.

With one final checkup to make sure our insurance policies are paid, we shall take off. As the rocket gets farther away from the earth's surface the sky seems to be getting blacker, and the sun whiter, since we are confronted with less atmosphere to reflect the blue of sunlight. By now, the rocket is out of the earth's atmosphere, and we are ready for optical measurements under the ideal conditions of outer space, such as lack of haze or dust, and temperature variations. We cannot observe directly by telescopic means, for the concentration of light would instantly blind us. Instead we can take a spectrograph of the sun. Then, by comparing the emission spectra to that of earth elements in an incandescent stage, we can identify at least 65 of the 92 elements on earth. Since some of the same elements are found by similar methods in remote stars, we have an indication that the earth, the sun, and the stars are basically the same, and that the sun itself is a star.

In order to get a complete picture of the sun, we have brought along an ingenious instrument, called the spectroheliograph. It consists of a telescopic camera with two slits. The first slit is at the focal plane of the telescope objective. A narrow beam of light passes through it and is analyzed by a spectroscope. A second slit allows one band of the spectroscopic image to fall upon a photographic plate. The telescope and slit are then moved at right angle to the sun's image, so that the whole solar surface is "scanned" and photographed in the light of one wavelength.

By examining such photographs, two curious and as yet unexplained phenomena are noticed. The first is the Flocculi, which are dark particles resembling granules, and which cover the surface of the sun. Since they are only visible when the sun is photographed in monochromatic light, they are probably surface clouds of gas, which are highly selective in their absorption, transmitting most of the light.

The second curiosity is sun spots. These are the vast areas of black spots, many of them being hundreds

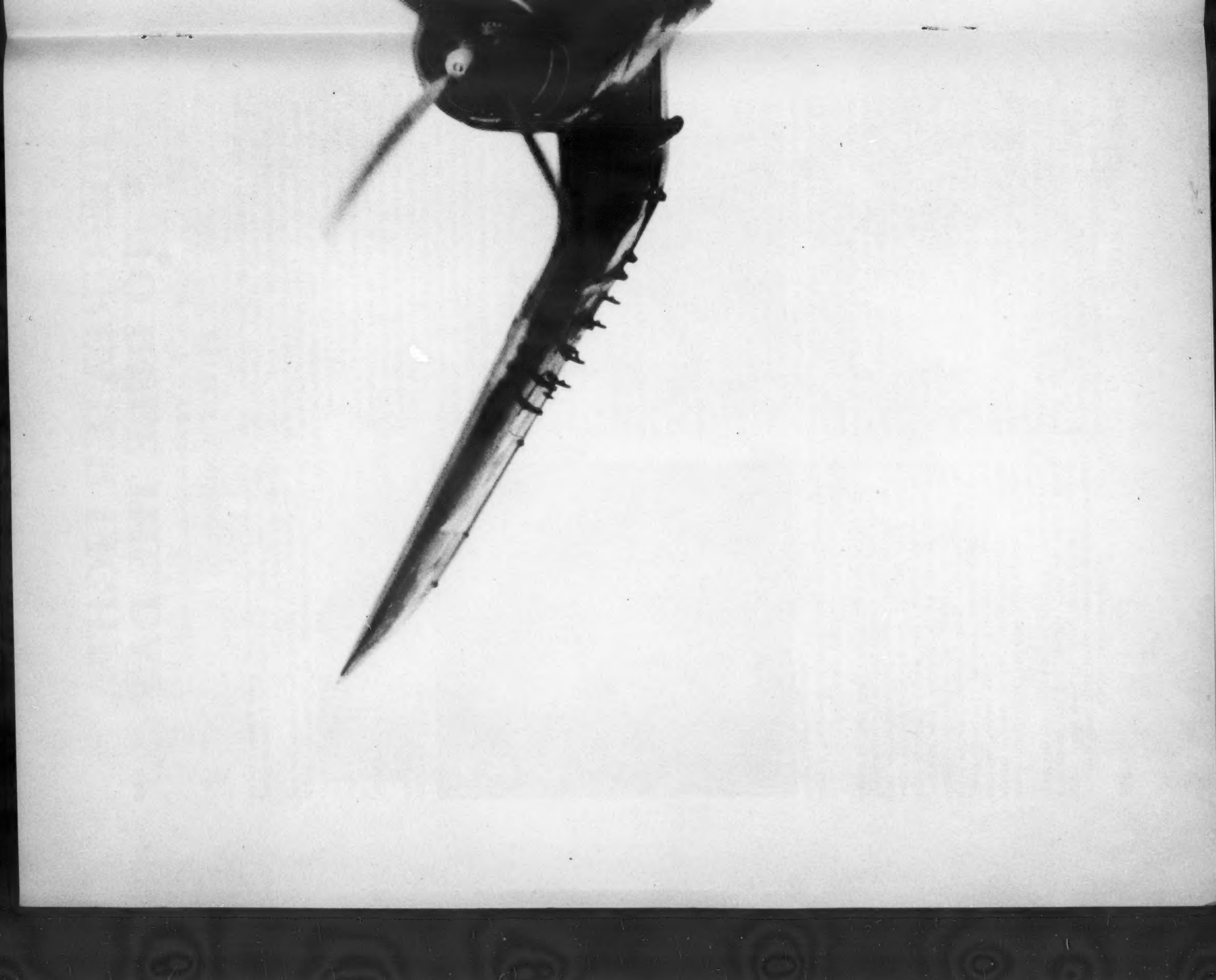
A. C. Crommelin, Greenwich Observatory

The Coronary Ant Eater solar prominence of May 29, 1919. It is about 350,000 miles long.

of times larger than the earth. They are not really black; they only seem so in contrast to the surrounding surface. Spectroscopic heat measurements show that they are about 4000° C., two thousand degrees cooler than the normal surface. They usually appear in pairs and exhibit Zeeman effects, showing plane polarized light when viewed normally, and circular polarization when viewed radially. Since magnetic effects on earth such as magnetic storms, compass variations, static, and the Aurora Borealis all vary with varying sun spot intensity, it seems logical that they are areas of intense magnification, somewhat analogous to magnetic storm areas on earth.

As the rocket journeys on, we notice that sun spots travel across the sun's surface, and that spots in a particular latitude move with the same speed, while spots in different latitude travel with quite different

(*Continued on page 302*)



Business end of the F4U-4 Corsair in flight.
Martin & Kelman

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Can You Do It?

THE NINTH IN A SERIES OF MONTHLY BRAINBUSTERS

THIS MONTH: *Two new ones—one elementary and one advanced . . .*

Problem 1: Given the following problem in multiplication, where a, b, c, x, y, and z are six different digits:

$$\begin{array}{r} a\ b\ c\ x\ y\ z \\ \times\quad\quad\quad 6 \\ \hline x\ y\ z\ a\ b\ c \end{array}$$

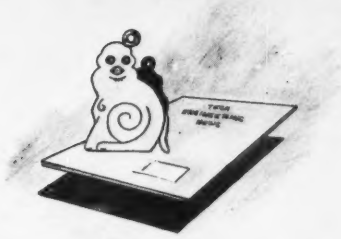
find the digits a, b, c, x, y, and z.

Problem 2: One morning it starts snowing. At noon, some public spirited soul gets out the snow plow and begins to clear the roads. The plow being mathematically minded, it runs at a speed inversely proportional to the depth of the snow. During the first hour, the plow goes two miles, but because of the increased depth of the snow, it only manages to go one mile between one and two that afternoon — the second hour. Assuming that the snow has been falling at a constant rate, what time did it start snowing? — *Courtesy of Warren S. Loud.*

Editor's note: This problem requires a certain knowledge of the elementary calculus. J. W. W.

(*Answers next month. Answers to last month's problems are on page 306*)

The Dragon's Den



Opportunity Knocks . . .

Pessimists insist that there is no further opportunity extant in the world for anyone, especially engineers. Naturally, we all disagree or we would not be studying engineering. However, it might be useful to point out just how tremendous the opportunities are.

The world is in the final stages of industrial revolution. Countries which up to the third decade of the century had been undeveloped or else exploited by more industrialized nations, have become interested in their industrial progress. Witness the increased influx of engineering students from foreign countries. Note that they are, for the most part, studying civil engineering, mechanical engineering, or electrical engineering. The governments of those countries which are paying for these students' educations certainly have no fantasies about what their history is going to be for the next twenty years. And this means that there is a field open for the enterprising engineer.

Unfortunately, the countries of the world have carried their fervor a bit too far; they have become infected with the virus of economic nationalism: favored nations, favored peoples, a modern revival of mercantilism without the "*laissez faire.*" For instance, if one wants to go to France, he may easily obtain a passport to visit, but, unless there are very unusual circumstances, he must also sign a paper stating that he will not engage in any remunerative labor while in the country of France. This indicates that France wants gold (or its virtual equivalent, the dollar) to move toward France, without being carried away again by a foreigner working there. Only a French engineer can work in France.

The French are not alone in their method of selection of employees; other European nations exhibit similar tendencies. Americans have the advantage of not living in a country where rebuilding destroyed industries is the major concern of the engineer: they can look for the "new."

The United States through the Export-Import Bank has poured three and one-half billion dollars down the Chinese sewer pipe; breakdowns are not available, but it is likely that less than one billion went for food and relief. It is evident, then, that the rest has been used for military purposes, for civil war, for the Japanese war and for the crutch under the Kuomintang government. Meanwhile, ruinous floods still occur each year in the vast valleys of the Yangtze, and Hwang Ho rivers. It has been reported many times that these losses could be avoided to a great extent by Authority control in the Yangtze at least, if not in both. This project would dwarf the Tennessee Valley Authority and could provide Middle China with enough power for industrialization. But the civil war continues, and it looks as if the American personnel and equipment which would be used will never be purchased for this purpose. China also has immense mineral deposits in her relatively unknown interior that might very well prove to be the world's backlog for many vanishing elements.

The "Truman doctrine" has been called "stained with oil." Perhaps this is not so, but it nevertheless is true that American and British oil companies will continue their control of Middle Eastern oil with the aid of this policy. New fields are being opened in Arabia and all the engineers needed for oil production are in demand. The pay is excellent and living accommodations are provided. The only drawback is that you must sign with the oil firm for a long time, from five to seven years.

And so it goes all over the world, in South America, in the Indies, in Central America, in Africa, and Asia. And, it would seem that if opportunities exist elsewhere, then the trade and business that these openings exist because of and through, must necessarily produce expansion of our own economy. There is no "panorama of prosperity" for the average individual, but gold still can fall at the feet of the engineer who is interested in it. If *that* is all he is interested in. Developing a country might, though, give an engineer a sense of accomplishment and pride such as he rarely gets from more prosaic occupations.

* * *

M. I. T. has established a Committee on Education to study the lack of cultural latitude in an engineer's training and to determine what can be done about it at Technology. Let us hope they come up with a progressive, interesting solution.

E. M. K.

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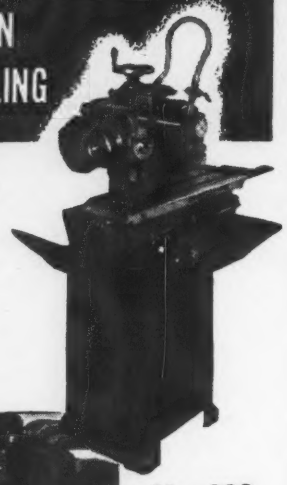
ON SMALL PARTS MILLING



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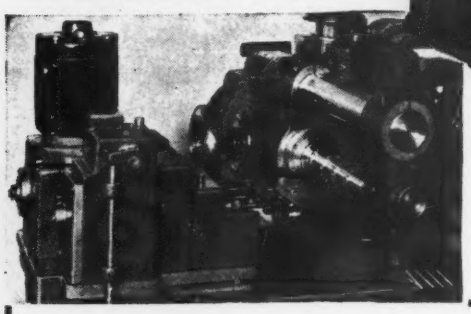

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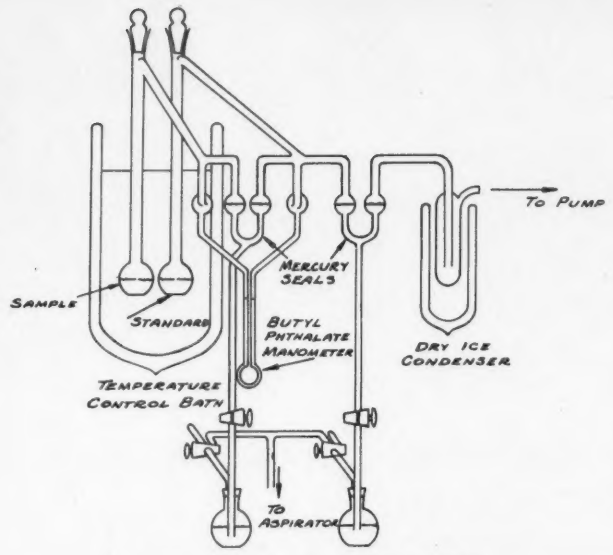


VAPOR PRESSURE APPARATUS

A similar situation exists in the newly developed process of rapid cooking, and this type of work is one of the applications of physics to food technology. An electronic device has recently been invented which is capable of cooking foods in as little as sixty seconds. This invention might revolutionize cooking and baking; if, as seems likely, it is found that this quick cooking retains more of the vitamins and natural flavor of the food than the old-fashioned type of cooking, and it can be made available at a reasonable cost, the electronic stove will probably come into common usage before long. Another application of physics is the study of the effects of sonic vibrations on food, a subject about which very little is known at the present time.

In the field of dehydration of foods much work is being done. We often speak in jest of the time when all of our eating will be done by means of capsules and

(*Continued on page 294*)

FOOD TECHNOLOGY

(*Continued from page 282*)

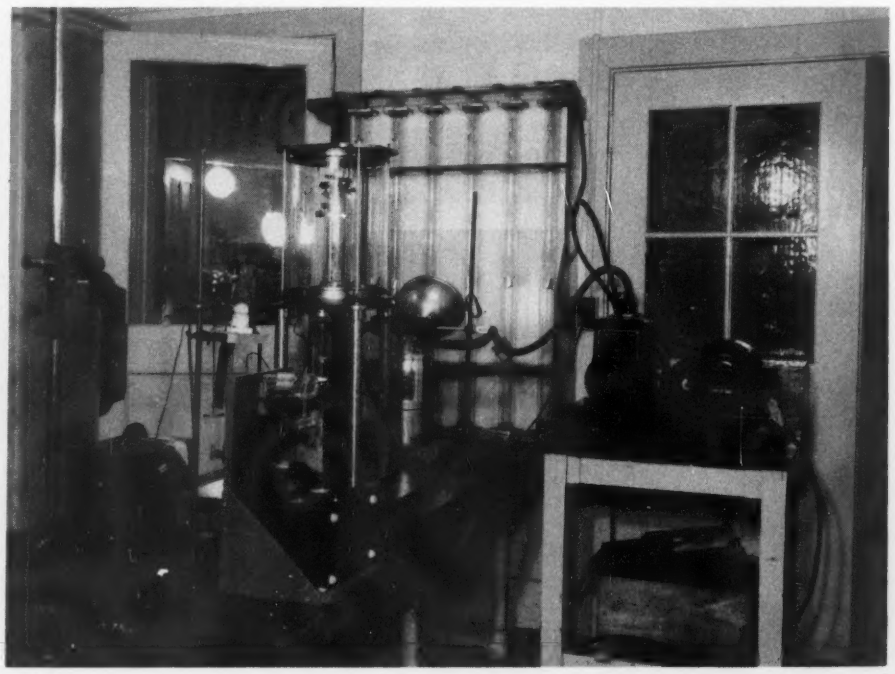
processes as rapid cooking, dehydration, and quick-freezing.

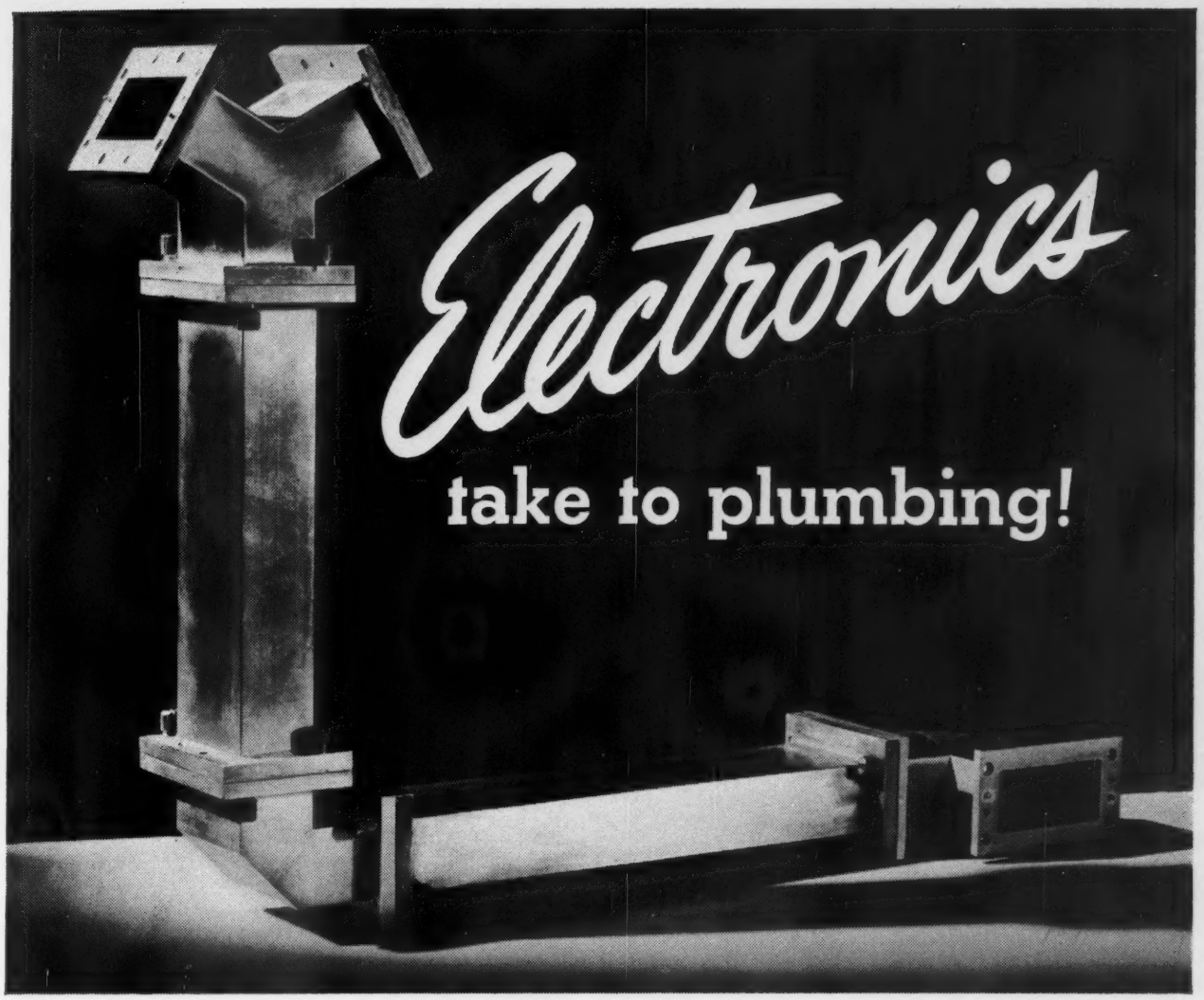
The frozen food industry is a comparatively new one, with extensive opportunities for all kinds of work. It is of vital importance in this industry to know what happens to the flavor and nutritive value of foods first when they are frozen, and then when they are thawed. The methods of food technology are well suited to this type of work, and considerable research on refrigeration and frozen foods is being conducted in the laboratories of the department.

A recent innovation in the technique of freezing foods is the process of freezing an entire meal together on a plate. All the consumer has to do is put the plate on the stove for a few minutes, and he has his whole meal in front of him, ready to eat. This process could be of particular value to the airlines, where space is at a premium, and in fact the process is already being tried out by some airlines. Of course, the effects of such a process on the flavor of the food must be evaluated if the process is to become successful.

A photograph of a portion of the food technology dehydration research laboratories. In the foreground is the vacuum chainomatic balance. Against the wall are long tubes used to measure the vapor pressures of dehydrated foods

Food Technology Department





HERE'S a new kind of pipe. It carries microwaves. It began to take shape in college.

A student was experimenting with the transmission of very short radio waves over wires immersed in a trough of water. The waves travelled along the wires as expected, but then he discovered a second set of waves in the trough—a set dependent not on the wires, but *guided* by the trough itself.

Several years later this student, then a scientist at the Bell Telephone Laboratories, became interested in the transmission of microwaves. He recalled his college experiment. Could a metal sheath be substituted for the trough? Would such a pipe line carry high frequency radio waves with greater efficiency than an ordinary line?

It could and it would: but the wave lengths available required pipe lines that were too bulky to be practical. Electron tubes were soon developed which generated shorter waves . . . waves which made it possible to use pipe lines of smaller, more manageable size. These pipe lines, known as waveguides, proved indispensable to radar in war. Now, with the invention of accessories to serve as coils and capacitors of wire circuits, waveguides are becoming an even more important part of our radio telephone and television systems.

Such men as this young scientist whose keen minds can recall early observations and apply them intelligently to new problems will find telephony a fascinating and a rewarding career.

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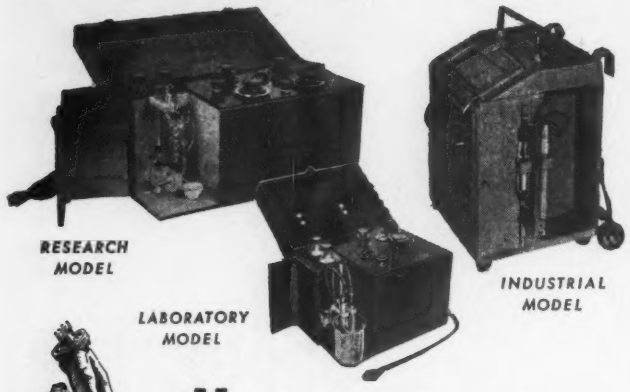

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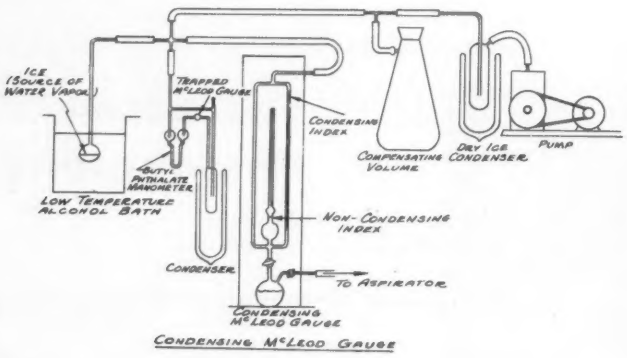
THERMOID COMPANY, TRENTON, N. J., U. S. A.

FOOD TECHNOLOGY

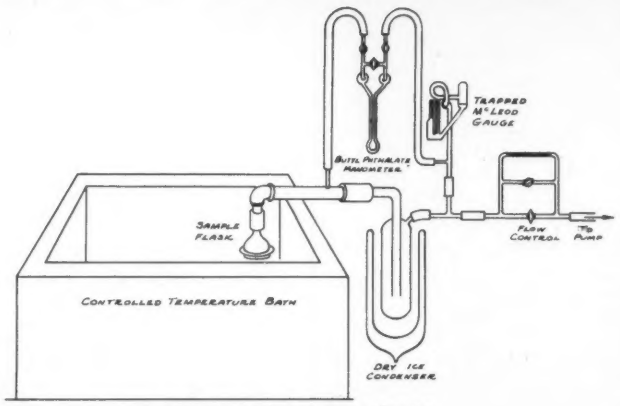
(Continued from page 290)

powders, but this idea is not so far-fetched as it may seem, for more and more foods are being subjected to dehydration. Among the most recent of these are fruit juices. It has been found that orange juice can be reduced to a powder; if this can be done without losing the Vitamin C, its chief nutritive constituent, then its dehydration will become practical. Otherwise, of course, there would be no value to the process. Similarly, the production of dried foods depends on whether the nutritive elements can be retained. The entire field of dehydration received its greatest stimulus as a result of the recent war, during which the armed forces were vitally interested in obtaining dehydrated foods of all varieties.

Another field to which many food technologists apply themselves is the actual cultivation of food. Different methods of planting, fertilizing, and cultivating food are studied in detail for their effects on the maturity, flavor, and tenderness of food. The effect of climate on the quality of crops is carefully studied, and in fact the whole idea of scientific farming is connected with food technology. Many food technologists do work on milk and dairy products, testing the effects of different diets supplied to the cows, and constantly trying to improve the quality of milk and dairy products. Here again a thorough knowledge of biology is essential.



CONDENSING McLEOD GAUGE



MOISTURE TEMPERATURE DRYER

The purification and safeguarding of food products is also a field in which many food technologists are employed. The question of how foods spoil, what is responsible for spoilage, and what can be done to combat it, is important in almost every phase of the food industry. The manner in which bacteria and molds attack foods is studied in minute detail, the practicability of such methods as x-rays and chemical detergents for use in fighting bacteria are being investigated.

(Continued on page 296)

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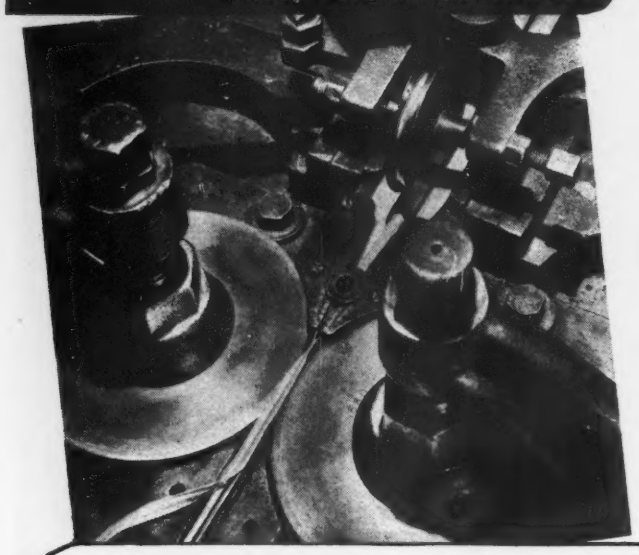

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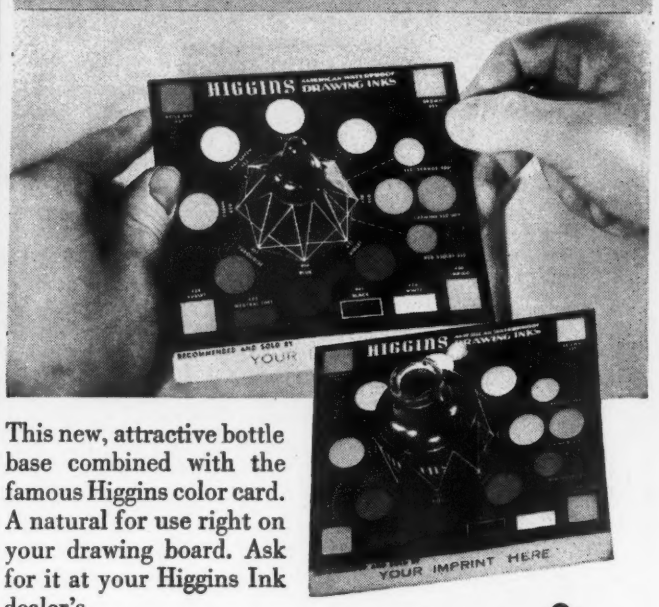

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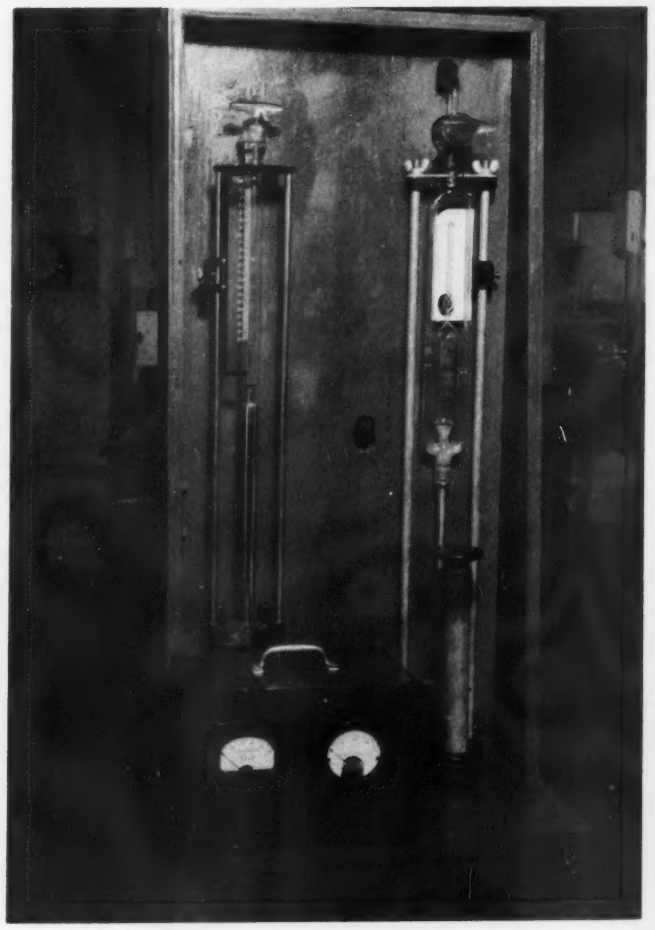
FOOD TECHNOLOGY

(*Continued from page 294*)

It is in such fields as electronic sterilization that the advantage of a broad scientific background becomes evident. Being acquainted with the electronic side of the problem as well as the bacteriological side, a graduate in Food Technology has a much better overall picture of the problem than an ordinary bacteriologist or the electronics man who works on the apparatus itself. In other words, the food technologist is a sort of link between the various sciences in their application to food.

Thus far we have spoken mainly of the chemical and biological side of food technology, and in particular of the research work involved. There exists also an engineering side to the field, which probably employs more men than the other. After all, for every man working on research, there must be many engaged in testing in actual practice the discoveries made in the laboratory, and in working out the technical questions involved. Many men are employed in the technical aspects of food production, manufacture, storage, and distribution. Many also go into business and executive positions with food companies, after having begun as technologists.

(*Continued on page 300*)



The three types of vacuum measuring devices used at the Food Technology laboratories. The box contains an ionization-type gauge. On the left is a pyrex direct reading gauge, and on the right is a McLeod gauge, graduated to a millimicron

Food Technology Department

Cottonseed given new chemical protection

DOW 9-B

SEED PROTECTANT

(CONTAINS ZINC TRICHLOROPHENATE)

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CHEMICAL COMMENTS

Sprout Stopper

Ambitious potatoes don't like to stop sprouting, even when sprouting means loss of weight, food value and marketability. Chemists at Dow have produced a sprout inhibitor that really says *Stop!* Its use also means that potato storehouses can be kept warmer . . . potato sugar content stays lower . . . potato chips keep their blond complexions, sell better. It works equally well with carrots, turnips and other root crops. (Naturally, it's *not* recommended for seed potatoes.)

Plastic Insulation That's Lighter-than-Cork

Take a plastic—to be specific, take Dow polystyrene—air-expand it until it honeycombs into a rigid material that is even lighter than cork—and you have Styrofoam. It's winning new laurels in the low temperature insulation field because of its high efficiency, extremely light weight, good strength and excellent stability. This is the same Styrofoam used to advantage in boats and canoes, life rafts, beach toys and novelties. It floats, and *stays* afloat, because its millions of tiny air cells are individually sealed.

Caustic Comment: *Did you know that caustic soda—one of man's most widely used and sorely needed chemicals—is the pickling ingredient that takes the bitterness out of green olives?*

New Washable Plastic Paints

The wearable, washable characteristics of plastics are now given to new plastic paints. A tough protective film is formed by plastic particles that bond themselves together. The paint, made possible by a new product called Saran F-122 Latex, dries extremely fast into a long-enduring glossy finish. These paints may be applied with either brush or spray to wood, fibreboard, metal or masonry.

Whiffs and Puffs

Many a favored brand of pipe tobacco is being forsaken for the new tobacco mixtures with a tantalizing blend of maple-licorice plus a definite suggestion of walnut. Secret of the new flavor fillip is the Dow aromatic specialty, Cyclotene . . . one of many man-made aromatics bringing forth new scents and tastes in soaps, cosmetics, flavors and perfumes.

Further information on any of these chemical developments is available on request.

DOW

CHEMICALS INDISPENSABLE
TO INDUSTRY AND AGRICULTURE

This message originally appeared in the Trenton (New Jersey) Times Advertiser.

WHAT DO YOU SEE IN YOUR NEIGHBOR?

TRENTON BY ORIGIN is a crossroads—a community of people drawn together from the four corners of the earth by any one of a number of attractions.

Being a part of this growing neighborhood is a responsibility, for its interests are your interests—its friends, your friends—its enemies, your enemies.

There was a time when cities like Trenton were protected against attack by great walls and strong gates. Today's assailants cannot be kept out by such primitive methods. They come into our midst like invisible Trojan horses, and their only weapons are theories and glib tongues.

Disguised as friends, they reveal themselves only after they have assembled enough followers to attack from within; when it is too late for us to do anything about it.

Their methods are simple: They work with us, agree with our ideals, and sympathize with our troubles. When they have won our confidence, when they have succeeded in getting themselves appointed to committees, and elected to offices... they turn upon us. Like the amiable tourists, who suddenly donned enemy uniforms, during the last war, they attack when we least expect it... when we are helpless against them. They usually begin by labeling our time-tried leaders with names which insure their downfall—but which describe the intruders best—and having succeeded in ousting our leaders, they take over.

Is it too late to do what stone walls and strong gates could not do? Do we want these dangerous men in our country, in our clubs, in our unions, in our businesses and in our government?

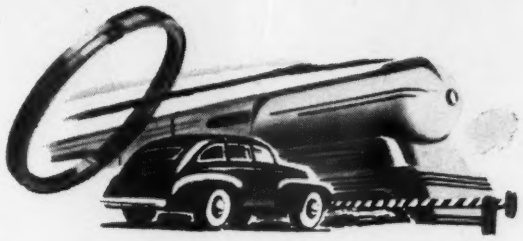
Let the man who wants to hold office identify himself. Let the man who wants to live with us and work with us, reveal his purpose. Let the man who wants to have a voice in our affairs, disclose his ambitions and ideals.

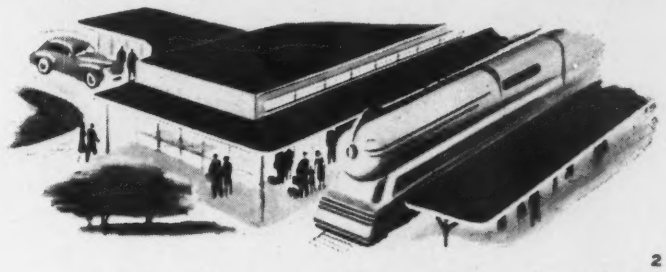
It is our duty to know our neighbors. We only can trust them when we do. "Good fences make good neighbors" and good neighbors make good cities—good governments —good unions—good businesses—good citizens

JOHN A. ROEBLING'S SONS COMPANY
TRENTON 2, NEW JERSEY

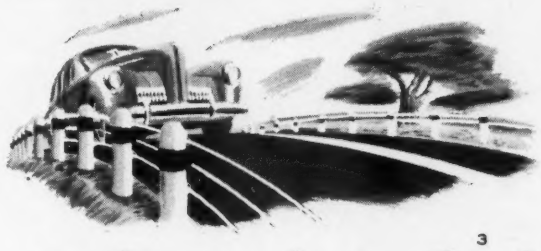
Manufacturers of Wire Rope and Strand • Fittings • Slings • Aircord, Aircord Terminals and Air Controls • Suspension Bridges and Cables • Aerial Wire Rope Systems Electrical Wire and Cable • Hard, Annealed or Tempered High and Low Carbon Fine and Specialty Wire, Flat Wire, Cold Rolled Strip and Cold Rolled Spring Steel Ski Lifts • Screen, Hardware and Industrial Wire Cloth • Lawn Mowers

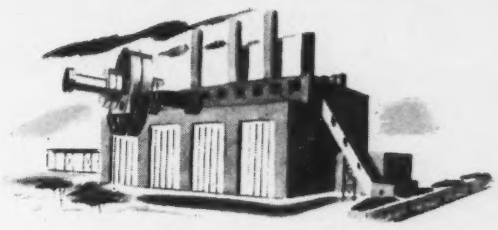
You saw us today...did you know us?





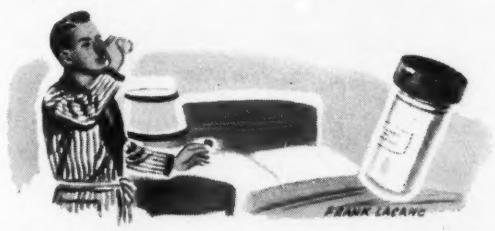
When you met the train[1] . . . . at the railroad station[2]





. . or drove along the highway[3] past a power plant[4] . . .

or past a coke plant[5] . . . . . mothproofed your winter clothes[6]



or took sulfa pills[7] . . . . . or played billiards[8] . . . . . .

K
KOPPERS

you saw a Koppers product in use.

1. American Hammered locomotive packing rings. **2.** Roofing and waterproofing materials. **3.** Pressure-treated highway guard posts. **4.** Fast's self-aligning couplings. **5.** Plants for manufacture of coke. **6.** Koppers HEX or Mothballs. **7.** Chemicals for drugs and medicines. **8.** Ingredients for plastics. Koppers makes all these products . . . and many others which serve you every day. That's why we call the Koppers trade-mark the symbol of a many-sided service. Wherever you see it, it means *quality*. Koppers Company, Inc., Pittsburgh 19, Pa.

The National Hotel at Havana uses Frick Refrig. for half a dozen services.

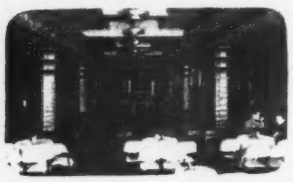
In Famous Restaurants Everywhere—

FRICK

Refrigeration

Main Dining Room at the Royal Hawaiian Hotel, Honolulu.

Performs half a dozen indispensable services — conditioning air, cooling drinking water, dispensing beverages, freezing ice, making ice cream, quick-freezing foods, and holding desired temperatures in any number of rooms and boxes—for meats, fish, poultry, dairy products, fruits, vegetables, frozen foods, candy, flowers, etc. Write for literature.



China is among the Eastern Countries that use Frick Air Conditioning and Refrig.

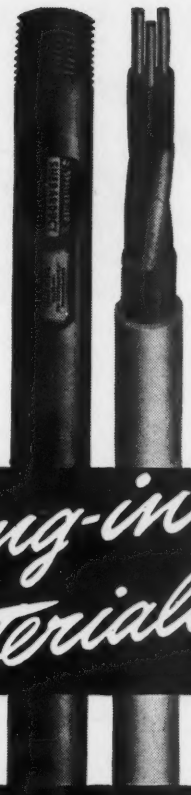
The Frick Graduate Training Course in Refrigeration and Air Conditioning, now in its 30th year, is approved under the G.I. Bill of Rights.

FRICK CO., Waynesboro, Pa.

NATIONAL ELECTRIC PRODUCTS WIRING SYSTEMS

WORLD'S LARGEST PRODUCERS OF ELECTRICAL

Roughing-in materials



WIRING SYSTEMS AND FITTINGS FOR EVERY CONCEIVABLE REQUIREMENT

National Electric
PRODUCTS CORPORATION
Box 897 — Pittsburgh 30, Pa.

FOOD TECHNOLOGY

(*Continued from page 296*)

The packaging of food materials is a field in which the engineering side of food technology is emphasized. The proper packaging of food is an important problem, and new substances, especially plastics, are being employed as wrappers. The object is to obtain packaging materials which will protect the food against spoilage, and allow as few of the nutrients and vitamins as possible to escape.

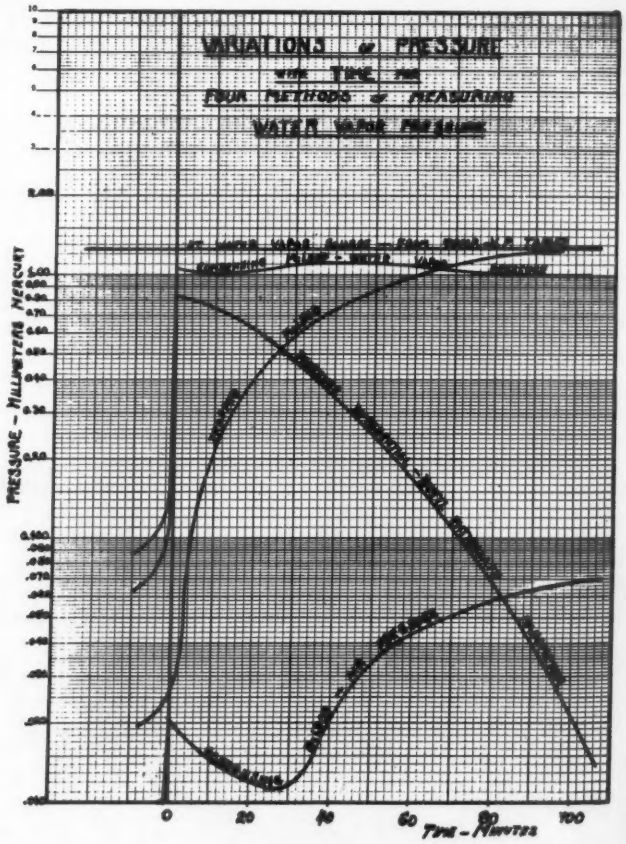
Most of the main points of the field open to food technologists have been mentioned. It is interesting to note that, of the fifty thousand-odd food industries in the United States, only about five thousand employ technical men. The remaining companies, mostly smaller enterprises, could benefit from the growing science of food technology by pooling resources and engaging in research, development, and engineering. The whole field is a wide-open one, but the answers to its questions will provide mankind with a better dinner table — and a safer one.

Next Month:

The Story of

R. M. S. "Queen Elizabeth"

Be sure and get your copy!



Food Technology Department

"... *Ignorance is the curse of God, knowledge the wing wherewith we fly to heaven.*"—SHAKESPEARE

Why some things get better all the time

HOOP SKIRTS AND PRINCE ALBERTS are only fond memories now. Far smarter the styles of today . . . and equally striking are the constant *improvements* in the *quality* of clothing.

There now are beautiful synthetic fabrics, in stunning variety—all made possible by chemistry. And woolens, cottons and other fabrics are processed and dyed more effectively—thanks to special new chemicals, and equipment of stainless steel. There are eye-catching hat decorations, smartly styled footwear, buttons, belts and suspenders of colorful long-life plastics. And rainwear of vinyl plastics provides new comfort and protection in stormy weather.

Clothing for just about any occasion is today more attractive and more serviceable than ever before... because it is made of things that are *basically better.*

Producing better basic materials for the use of science and industry and the benefit of mankind is the work of UNION CARBIDE.

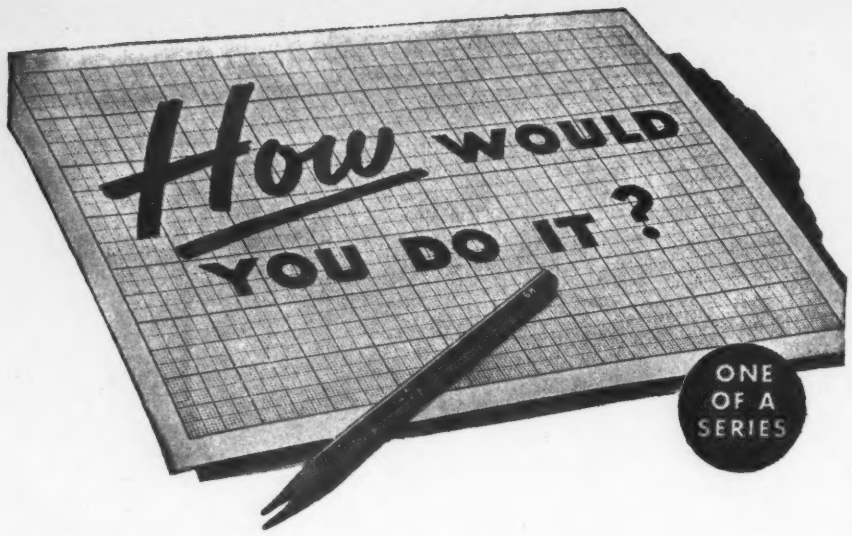
Basic knowledge and persistent research are required, particularly in the fields of science and engineering. Working with extremes of heat and cold—frequently as high as 6000° or as low as 300° below zero, Fahrenheit—and with vacuums and great pressures, Units of UCC now separate or combine nearly one-half of the many elements of the earth.

UNION CARBIDE
AND CARBON CORPORATION

30 EAST 42ND STREET UCC NEW YORK 17, N. Y.

Products of Divisions and Units include

LINDE OXYGEN • PREST-O-LITE ACETYLENE • PYROFAX GAS • BAKELITE, KRENE, VINYON, AND VINYLITE PLASTICS
ACHESON ELECTRODES • EVEREADY FLASHLIGHTS AND BATTERIES • NATIONAL CARBONS
PRESTONE AND TREK ANTI-FREEZES • ELECTROMET ALLOYS AND METALS • HAYNES STELLITE ALLOYS • SYNTHETIC ORGANIC CHEMICALS



PROBLEM — You are designing a machine for doing finishing operations on the production line, such as grinding, polishing, buffing, etc. Your problem is to provide a drive that permits the grinding or polishing wheel to be moved around freely while it is running. How would you do it?

THE SIMPLE SOLUTION —Use an S.S.White power drive flexible shaft to transmit rotary power from a suspended or pedestal-mounted electric motor to the handpiece which holds the finishing wheel. This gives you a portable unit that permits the wheel to be readily manipulated to reach all points.

* * *

This is just one of hundreds of power drive and remote control problems to which S.S.White flexible shafts are the simple answer. That's why every engineer should be familiar with the range and scope of these useful "Metal Muscles"* for mechanical bodies.

Here's how one manufacturer did it.

WRITE FOR BULLETIN 4501

It gives essential facts and engineering data about flexible shafts and their application. A copy is yours for the asking.

Write today.

* Trademark Reg. U. S. Pat. Off. and elsewhere

S.S.WHITE INDUSTRIAL DIVISION

THE S. S. WHITE DENTAL MFG. CO. DEPT. C, 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
SMALL CUTTING AND GRINDING TOOLS • SPECIAL FORMULA RUBBERS
MOLDED RUBBERS • PLASTIC SPECIALTIES • CONTRACT PLASTICS MOLDING

One of America's AAAA Industrial Enterprises

THE GREATER LIGHT

(*Continued from page 285*)

speeds. If we photograph the sun continuously, we can notice that the spots travel across the surface from east to west, then disappear for about the same length of time that they took to cross it, and then reappear on the eastern limb. It seems obvious then, that the sun is rotating about an axis, and that all parts of it are not moving at the same speed. Thus we know that the sun is a ball of gas, rotating with a calculated period of 24.6 days at the equator, and 33.6 days at latitude $\pm 80°$. There is another unexplained phenomenon concerning sun spots. It is that they all experience a cycle of approximately 11.2 years from maximum intensity to minimum, and back to maximum. No one knows why this is so. These cycles have so stirred the imaginations of scientists, however, that they have seriously attempted to correlate them to everything from financial crises to the quality of fur bearing animals.

By this time the rocket is approaching the surface of the sun. Precautions have to be taken to protect it from 6000° temperature of the surface and from a gravity of 27.6 g. Offhand, I can think of no suitable protection, but let it pass.

The first layer of the sun that we shall hit is the ethereal and exquisitely beautiful corona, visible from the earth only during a natural or artificial eclipse. It is a pearly white layer of gas some 300,000 miles deep. We know that it is extremely tenuous, since we, like the comet of 1882, can pass through it without the slightest deviation from our course. A spectral analysis of coronal light shows that it is partly incandescent, but mostly reflected from the sun's interior. Out from the corona we can see pulsating streamers which are believed to be caused by sun spot activity.

Next is the chromosphere. It is a colored layer of light gases, mainly hydrogen and helium, the latter of which, by the way, was known to exist on the sun long before it was discovered on earth. Spouting out from the chromosphere are some of the most fantastic spectacles in nature — solar prominences. They are monstrous sheets of superheated hydrogen and calcium gases. Some of them stretch out for 5,000,000 miles, continually twisting and jumping about at speeds over 12,000 miles a minute.

To pass to the next layer is more difficult, for we are approaching the

(*Continued on page 308*)

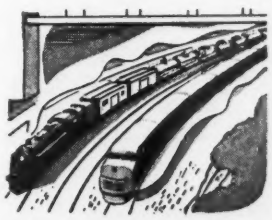
We're not so hot on POGO STICKS

Lots of people like to play jack rabbit. Still, as a way of going to work every morning, we don't see much of a future for Pogo Sticks. Not even *aluminum* Pogo Sticks.

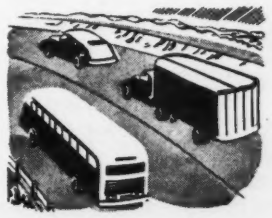
But mention any other means of locomotion or transportation and our aluminum "Imagineers" get a gleam in their eyes. After all, what is more logical than vehicles made of aluminum? Less weight to move. More payload.

We turned our imagination loose on that idea years ago . . . then engineered our thinking into trains, trucks, planes, ships. Alcoa's Development Division has a staff of "Imagineers" who think of nothing else but better ways to transport people, products, and materials by using aluminum. Actually, we have *four separate* staffs of transportation engineers, one each on railroads, highway vehicles, ships and aircraft.

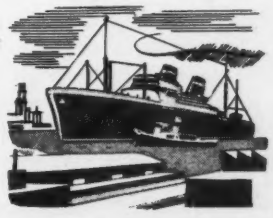
Whatever you do after college, you'll benefit from that. If you go into transportation, these Alcoa engineers will be working with you to cut costs, speed schedules, improve facilities. Or if you choose some field of production, they'll be helping to transport your materials and finished goods cheaper and faster. ALUMINUM COMPANY OF AMERICA, Gulf Building, Pittsburgh 19, Pennsylvania.



Passenger streamliners, refrigerator cars, hopper cars and tank cars built of Alcoa Aluminum are serving American railroads.



Alcoa Aluminum is finding more and more uses in buses, trucks and trailers. Yes, in passenger car manufacture, too.



Newest thing in shipbuilding is the aluminum superstructure, developed by Alcoa with marine architects and engineers.

Ever since Kitty Hawk, Alcoa has worked with the aircraft industry in developing better aluminum for better planes.

ALCOA FIRST IN ALUMINUM

Massachusetts Institute of Technology
CAMBRIDGE, MASSACHUSETTS

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY
offers the following Professional Courses

SCHOOL OF ARCHITECTURE AND PLANNING

Architecture

City Planning

SCHOOL OF SCIENCE

Chemistry
Food Technology
Food Technology — Five Year Course
General Science
Geology
Mathematics
  Options: Pure and Applied Mathematics
           Industrial Statistics
Physical Biology
Physics
Quantitative Biology

SCHOOL OF ENGINEERING

Aeronautical Engineering

Building Engineering and Construction
  Options: Heavy Construction
           Light Construction

Business and Engineering Administration
  Courses: Based on Physical Sciences
           Based on Chemical Sciences

Chemical Engineering

Chemical Engineering Practice

Civil Engineering
  Group Electives:
    Sanitary Engineering
    Transportation Engineering
    Hydraulic Engineering
    General Engineering

Economics and Engineering
  Options: Human Relations
           Industrial Relations

Electrical Engineering
  Options: Electric Power
           Illumination Engineering
           Electrical Communications
           Electronic Applications

Electrical Engineering
  Co-operative Course

General Engineering

Marine Transportation

Mechanical Engineering
  Options: General Mechanical Engineering
           Engineering Science
           Automotive Engineering

Mechanical Engineering-
  Co-operative Course

Metallurgy
  Options: Metallurgy
           Mineral Dressing

Meteorology

Naval Architecture and Marine Engineering

The duration of each of the above undergraduate Courses is four academic years, with the exception of Architecture, Food Technology (Five Year Course), Physical Biology, and the Co-operative Courses in Electrical Engineering and in Mechanical Engineering, which extend over a period of five years. In addition to the Bachelor's degree, the above five year courses, with the exception of Architecture, lead also to the Master's degree.

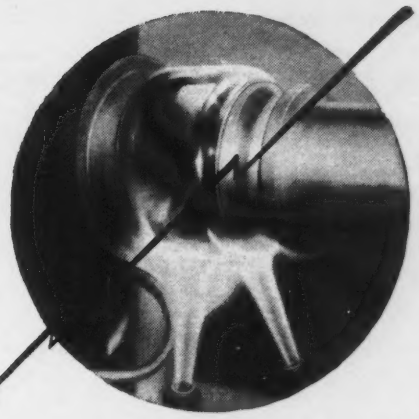
Graduate study, leading to the Master's and Doctor's degrees, is offered in Ceramics and in most of the above professional Courses.

A five year Course is offered which combines study in Engineering or Science, and Economics. This leads to the degree of Bachelor of Science in the professional field, and to the degree of Master of Science in Economics and Engineering or Economics and Natural Science.

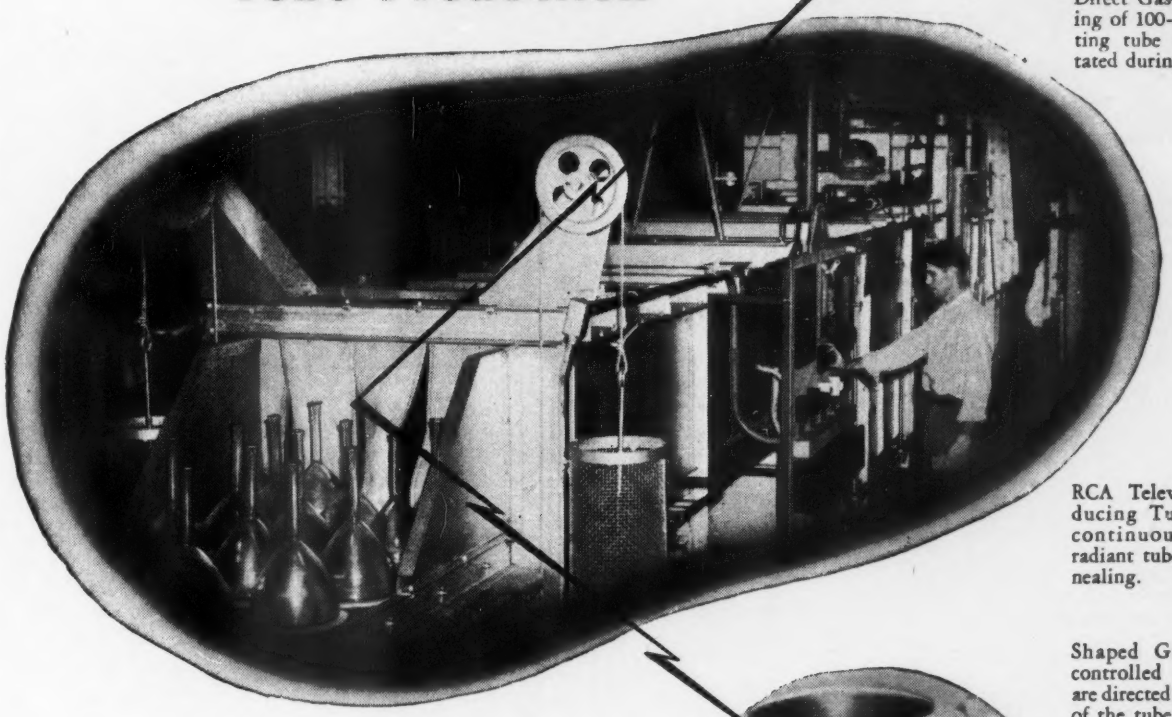
For information about admission, communicate with the Director of Admissions.

The Catalogue for the academic year will be sent free on request.

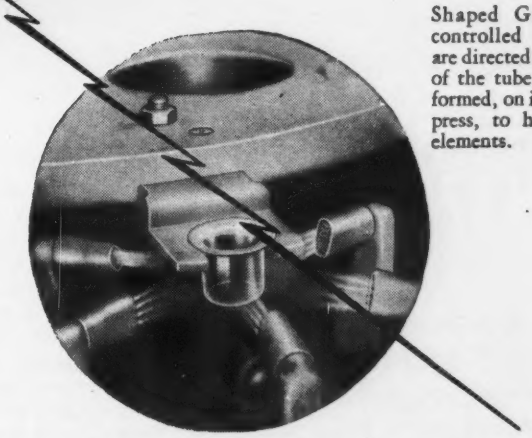
Flexible GAS Speeds RCA TELEVISION Tube Production



Direct Gas-flame annealing of 100-KW transmitting tube which is rotated during process.



RCA Television Reproducing Tubes leaving continuous Gas-fired radiant tube lehr for annealing.



Shaped Gas-flames at controlled temperatures are directed to exact areas of the tube stem as it is formed, on indexing-head press, to hold the tube elements.

IN the manufacture of television transmitting and receiving tubes the productive flames of GAS demonstrate the full scope of their flexibility and controllability.

Production engineers and equipment designers at RCA tube plant in Lancaster, Pennsylvania, have utilized GAS as a production-line tool throughout the vast, modern plant devoted to electron tube manufacturing.

With shaped-flames, radiant-tube lehrs, direct-annealing flames—with a wide range of accurately controlled temperatures—with burners of all types assembled as integral elements of continuous process machinery, RCA productioneers have taken full advantage of the universal adaptability of GAS and modern Gas Burning Equipment.

GAS and modern Gas Equipment are making major contributions to increased production in heating and heat treating operations throughout industry.

AMERICAN GAS ASSOCIATION

420 LEXINGTON AVENUE, NEW YORK 17, N. Y.

MORE AND MORE...

THE TREND IS TO GAS

FOR ALL INDUSTRIAL HEATING

Answers to last month's

Can You Do It?

Problem 1: If we think of the number 359,999 as (360,000−1) we can factor it easily into the expressions (600−1) and (600+1). Thus the factors of 359,999 are 601 and 599. Easy?

Problem 2: This one can easily be solved by setting up the expression

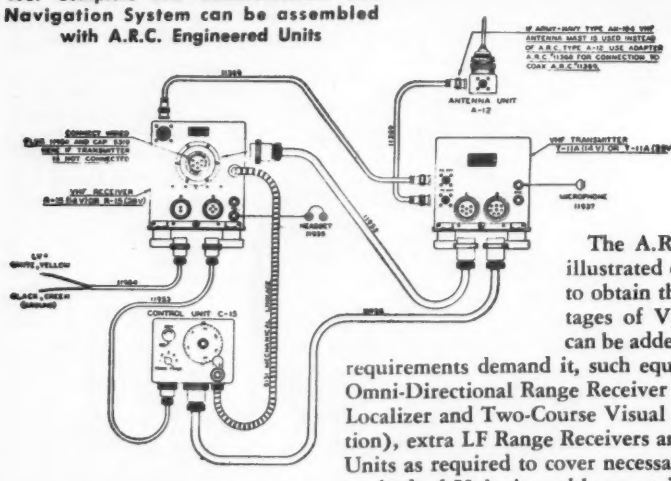
$$\frac{1}{4}x+\frac{1}{5}x+\frac{1}{3}x+13=x.$$

Solving, we find that Democharés is sixty years old.

Problem 3: If there were twelve ladies in all, there would be 132 kisses among the ladies alone, leaving twelve more to be exchanged with the curate — six to be given by him and six to be received. Therefore of the twelve ladies, six would be his sisters. Consequently, if twelve could do the work in four and a half months, six ladies would do it in nine months. — *Canterbury Puzzles.*

The Practical Approach to...

Your Complete VHF Communication and Navigation System can be assembled with A.R.C. Engineered Units



The A.R.C. Type 17 System illustrated can be installed now to obtain the immediate advantages of VHF. To this system can be added, when operational requirements demand it, such equipment as the VHF Omni-Directional Range Receiver (with provision for Localizer and Two-Course Visual Aural Range operation), extra LF Range Receivers and VHF Transmitter Units as required to cover necessary frequencies. This method of Unit Assembly was pioneered by A.R.C., and provides a flexible installation, quickly removable for maintenance and adaptable to individual operational needs.

With VHF communication and navigation facilities increasing throughout the country, now is the time to plan for VHF in your aircraft. For full information, write:

GOOD DESIGN TAKES TIME

Over four years of development lies behind current production of the tunable VHF Receiver, heart of the Type 17 and other A.R.C. multi-channel VHF Systems. This is your assurance of dependable performance.

A Aircraft Radio Corporation
DEPENDABLE COMMUNICATION AND NAVIGATION EQUIPMENT
Boonton, N. J.

WMIT—THE BEAVER NETWORK

(*Continued from page 284*)

of R.F. are fed into it at the transmitter at between one and two watts; this line is then connected to the power feeder in the dormitories as shown in Figure 4. Despite this relatively low power, reception in both the New and Old Dorms is good.

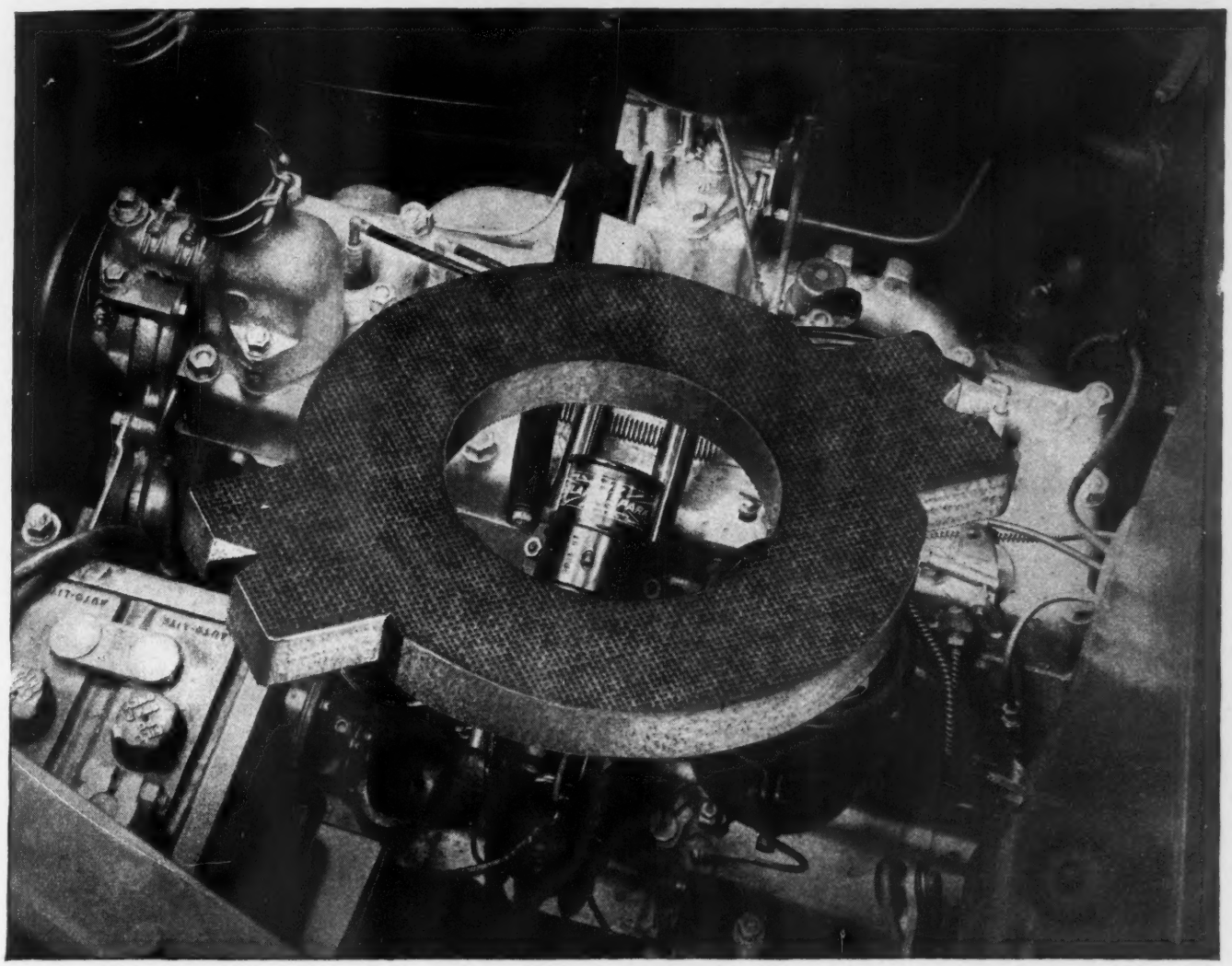
The fact that such low power may be used is due to the method of coupling which makes the power lines in that section of the dormitories act somewhat like an antenna. Exactly how this takes place is rather difficult to see: the R.F. circuit perhaps looks similar to the sketch shown in Figure 5. As a radiator this line is not at all efficient, but it works quite well.

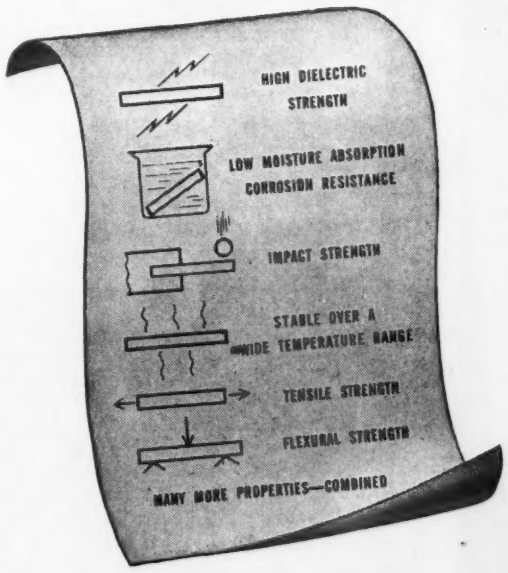
There are several advantages to this system of coupling over the direct coupled system as used in the Senior House. First of all the signal strength is higher for a given amount of power, and second the 60-cycle hum in radio receivers is noticeably less when this method is used.

The problem of hum due to transmission line conditions is present regardless of the method by which the R.F. signal is coupled to the power line. The causes of this hum are thought to be mainly due to the variation of the R.F. impedance of the power line at a 60-cycle rate. This would be caused by the heating and resultant non-linear impedance of incandescent lamps, etc.

Hum is to a great extent unavoidable and may be best reduced by increasing the R.F. signal strength wherever possible. For this reason WMIT is installing transmission lines upon which high R.F. voltages may be impressed. These lines will connect the transmitter in the Senior House to the Graduate House and the Building 22 "Plywood Palace," with a possible extension to Westgate.

Plastics where plastics belong
for resistance to wear and moisture





Synthane where Synthane belongs

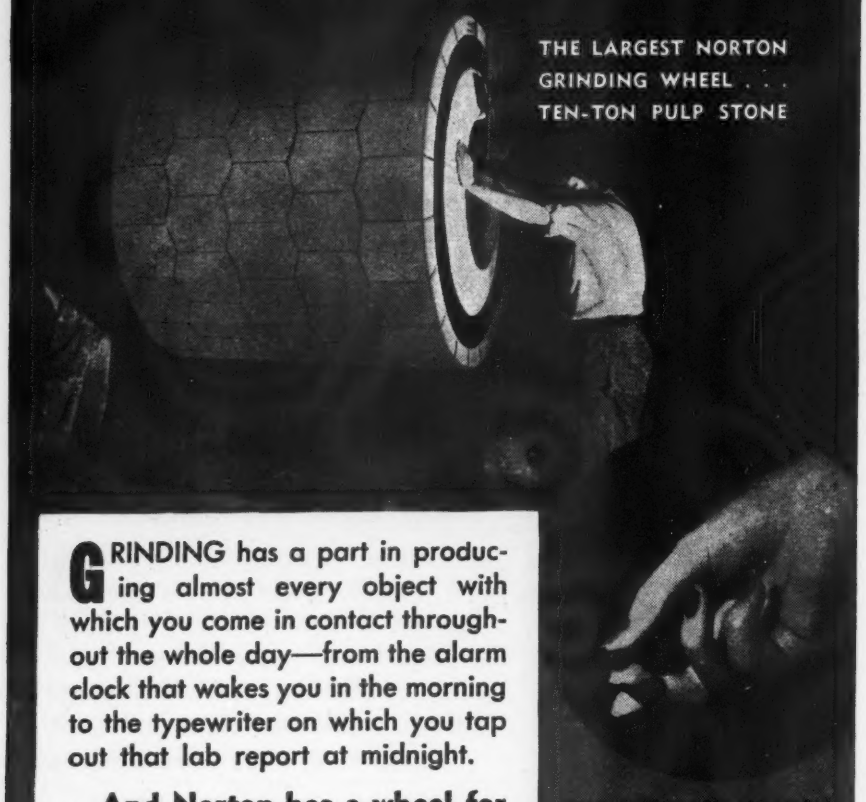
HERE's Synthane (our type of laminated plastics) at work in the water pump of a popular car, where resistance to wear and moisture are important.

This seal washer is lapped to fit precisely, seals watertight without packing, resists—mile after mile—the inroads of engine cooling water. It's an appropriate job for moisture-resistant Synthane, a good example of using plastics where plastics belong. Synthane has many other unusual mechanical, electrical, physical and chemical properties. It is light (½ the weight of aluminum), dense, strong, resists heat, impact, corrosion, is a good electrical insulator, and easily machined. It is a practicable material for a limitless number of applications. Synthane Corporation (Key Address) Oaks, Pennsylvania.

SYNTHANE

SYNTHANE TECHNICAL PLASTICS • DESIGN • MATERIALS • FABRICATION • SHEETS • RODS • TUBES • FABRICATED PARTS • MOLDED-MACERATED • MOLDED LAMINATED

NORTON Meets Every GRINDING WHEEL Demand of Industry



GRINDING has a part in producing almost every object with which you come in contact throughout the whole day—from the alarm clock that wakes you in the morning to the typewriter on which you tap out that lab report at midnight.

And Norton has a wheel for every grinding job. They range from the gigantic ten-ton pulpstones that grind wood into pulp for your newspaper to the tiny wheels used by makers of delicate instruments for the laboratory.

There are wheels of ALUNDUM abrasive (aluminum oxide) for grinding steels, wheels of CRYSTOLON abrasive (silicon carbide) for the non-ferrous metals and for non-metallic materials, and wheels of genuine diamonds for grinding the cemented carbides, glass, ceramics, stone and other super-hard materials.

NORTON COMPANY, WORCESTER 6, MASS.

RESEARCH

In the NORTON research laboratories at Worcester and at Chippawa over 125 skilled scientists and technicians are constantly at work developing new or improved abrasives and bonds for Norton grinding wheels.

NORTON

ABRASIVES — GRINDING WHEELS — GRINDING AND LAPPING MACHINES
REFRACTORIES — POROUS MEDIUMS — NON-SLIP FLOORS — NORBIDE PRODUCTS
LABELING MACHINES BEHR-MANNING DIVISION COATED ABRASIVES AND SHARPENING STONES

THE GREATER LIGHT

(*Continued from page 302*)

areas of intense radiation pressure, exerted radially outward, which combat the contracting forces of gas pressure and gravity, and keep the sun from either exploding or collapsing. This area is known as the reversing layer. The name comes from the fact that spectral analysis of light from this layer shows two complete reversals from light to dark, in the emission bands. It is in this region that the majority of the Fraunhofer lines lie.

The main body is called the photosphere. As we pass through it, we can see the greatest source of energy in our galaxy — the interior of a star. The closer we get to the center, the heavier are the ions that we find; for radiation pressure, gravity, and an interior temperature of over 20,000,000° C. have segregated them from the lighter gases and driven them to the center. As we get nearer, we see atoms whose nuclei are so large that whatever electrons are left to whirl around them come cloze to grazing the nuclei. Once in a while an electron will become attached to a super-heavy ionized atom, and will be forced to pass through the nucleus, setting off the fission reaction which produces the sun's power. We are not quite sure that this is the only cause of radiation, for as we start outwards, we can observe a carbon cycle in operation, in which four hydrogen atoms of atomic weight 1.008 combine to form one helium atom of atomic weight 4.004. The excess of .028 goes into radiation, producing 25×10^{19} ergs per gram of helium.

We are leaving the sun now, tossing about like a cork on the vast waves of radiation that pour out. We will have a difficult time finding the earth again, which will be visible only as a tiny speck in space. Perhaps, when we do find it, and set our course on an orbit that will intercent the earth's orbit as it whirls around the sun, we can take one last look at the star we have visited, and watch it hurtling through space towards a point between Vega and the great star cluster of Hercules, belching 240 million tons of matter every minute, and yet so massive that it is destined to live for 12 billion years more, before it fades into oblivion. And on the long journey home, we can wonder that from out of this fiery monster, there ever came a special breed of fly speck, who could dream these dreams of space conquered, and decree the destiny and death of the sun itself.

Du Pont *Digest*

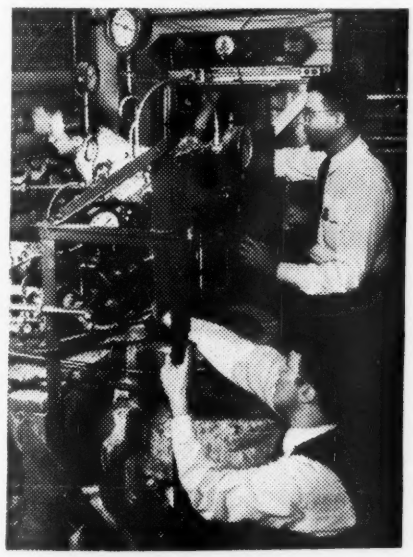
Items of Interest to Students of Science and Engineering

Research Problems in the Manufacture of Nylon

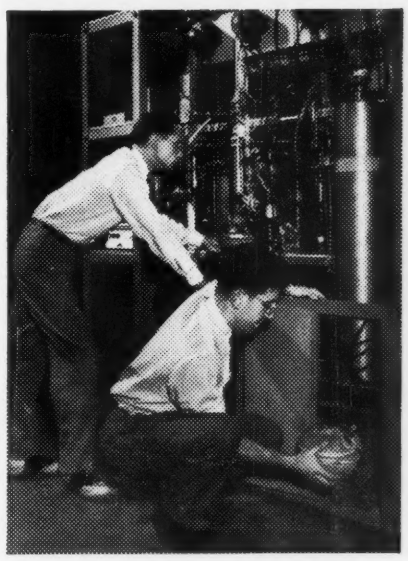
Last month in this space the development of nylon was traced from a fundamental research study on linear polymers to the first synthetic organic fibers, the superpolyamides. This installment deals with the complex manufacturing research problems that followed.

From the start there were obstacles to the production on a commercial scale of the "66" polymer—so named because the adipic acid and hexamethylenediamine from which it is made have six carbon atoms each.

Although adipic acid was being produced in Germany, it was necessary to develop a new process to meet conditions at Du Pont's Belle, W.Va., plant, where, because of the catalytic technique involved, it was decided to make this intermediate. Hexamethylenediamine was only a laboratory curiosity, and a process for its commercial production had likewise to be worked out. Fortunately it was found that the diamine could be made from adipic acid by new catalytic processes. The results of these investigations may be summarized as follows:



Carrying out experimental autoclave polymerizations of condensation polymers. J. H. Blomquist, Ph.D. Chemistry, Ohio State University '41; O. A. Bredeson, Ph.D. Chemistry, M. I. T. '41; J. E. Waltz, Ph.D. Chemistry, University of Indiana '41.



Studying the distillation of new intermediates for condensation polymers: T. J. Dickerson, B. S. Mechanical Engineering, Virginia '43 and E. E. Magat, Ph.D. Organic Chemistry, M.I.T. '45.

$$C_6H_6 \xrightarrow[\text{Benzene}]{H_2} \underset{\text{Cyclohexane}}{C_6H_{12}} \xrightarrow[]{O_2} \underset{\text{Adipic Acid}}{(CH_2)_4(COOH)_2}$$

$$\xrightarrow[-H_2O]{+NH_3} \underset{\text{Adiponitrile}}{(CH_2)_4(CN)_2} \xrightarrow[]{H_2} \underset{\text{Hexamethylenediamine}}{(CH_2)_6(NH_2)_2}$$

$$\underset{\text{Adipic Acid}}{(CH_2)_4(COOH)_2} + \underset{\text{Hexamethylenediamine}}{(CH_2)_6(NH_2)_2} \longrightarrow$$

$$\underset{\text{Nylon Salt}}{[HOOC(CH_2)_4COOH....NH_2(CH_2)_6NH_2]_x}$$

$$\underset{\text{A Nylon Polymer}}{[....CO(CH_2)_4CONH(CH_2)_6NH....]_x}$$

The synthesis of intermediates was only part of the problem. Nylon polymer was an entirely new material with properties different from any previous synthetic product. It provided the first example of spinning fiber from a molten polymer (m.p.263°C) and required entirely different techniques from rayon spinning. Information was acquired only by painstaking experimentation at each step.

Manufacturing Process Outlined

The process as finally developed for the manufacture of nylon and its fabrication into yarn may be briefly outlined as follows:

Nylon salt is heated in an autoclave with addition of stabilizers to control molecular weight and viscosity. A long-chain linear polymer is formed with a molecular weight of 10,000 or higher.

The melt is converted to solid chips that are later re-melted and extruded through a spinneret to form filaments at a speed of 2,500 feet a minute. The filaments are then drawn out to about four times their original length in order to develop the desired textile qualities characteristic of nylon.

These operations sound simple enough, but some of the problems encountered were extraordinarily difficult. For example, a specially designed grid for melting the polymer was necessary because of the poor thermal conductivity of the polymer; pumps had to operate at 285°C with only polymer as a lubricant; special abrasion-resistant steels that did not soften or warp at 285°C were necessary; the spinning assembling required radically new engineering developments to produce the necessary fiber qualities.

All of these chemical, physical and mechanical engineering problems had to be solved and dove-tailed into a unified process before manufacture of nylon could be undertaken. In all, about 230 technical men and eight manufacturing and staff departments share the credit for making nylon the important part of American life it is today.

More facts about Du Pont—**Listen to "Cavalcade of America," Mondays, 8 P.M. EST, on NBC**

Questions College Men ask about working with Du Pont

WHAT ARE THE OPPORTUNITIES FOR ENGINEERS?

Most openings at Du Pont are for chemical and mechanical engineers, but opportunities are also available for industrial, civil, electrical, metallurgical, textile, petroleum and other engineers. Practically all types of engineering are required in the work of the ten manufacturing departments as well as in some of the staff departments. Write for the booklet, "The Du Pont Company and the College Graduate." 2521 Nemours Bldg., Wilmington 98, Delaware.

DU PONT

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MAKING AN ART A SCIENCE

G-E Research helps to modernize the craft of Varnish Making

Rembrandt and Frans Hals were pioneers in the varnish industry. For it was the old masters of the Dutch and Flemish schools who discovered that boiled linseed oil, mixed with color pigments, provided an excellent paint vehicle.

For nearly 400 years, linseed oil, with a few other materials (like rosin, metal salts of rosin, tung oil, and asphalt), remained the basis of the paint and varnish maker's formulations.

Then came many technical advances.

New and remarkable synthetic materials began to replace time-honored formulas. And a leader in the research which was to change an ancient art to a modern science was General Electric.

Insulating Copper Wire

General Electric's interest in varnishes and resins begins with its interest in copper wire—essential component of motors, generators, and all power-producing and distributing apparatus. Many a good engineer has perspired freely over problems incident to insulating copper windings. Early enamels used for the purpose were considered satisfactory if, with careful handling, they would adhere to the wire at least until the operations involved in winding the coils were completed.

Present synthetic wire enamels, developed by General Electric's Resin and Insulation Materials Division, are specially designed for each size and type of wire. Their superiority to older types is so great that revolutionary changes in motor assembly have been made possible by their use.

Along Came Glyptal Alkyd Resins

General Electric's research work in this field has gone far beyond the study of insulating varnishes. Among the most notable G-E developments are Glyptal alkyd resins. Glyptal alkyd resins were originally produced more than thirty

years ago in General Electric's Pittsfield Works Laboratory. Since then, they have been vastly improved and their use expanded to make possible many types of baking enamels and paints that provide amazing durability and toughness.

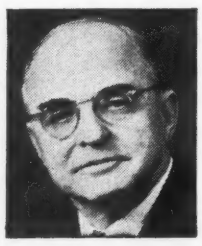
The Future of Silicones

And now, with General Electric's interest in new types of resin and varnish research expanding, much emphasis is being placed upon the study of silicones. Up in Waterford, N.Y., General Electric is rushing to completion a new plant which will turn out silicones in quantity. These amazing products of organo-silicon chemistry are characterized by high resistance to heat and cold. Silicone

rubber, silicone oil, silicone greases, silicone resins for paints and varnishes, are all expected to have many uses where this ability to withstand temperature extremes is important.

G. E.—A Great Name In Research

The Resin and Insulation Materials Division is just one branch of General Electric's Chemical Department where research is opening new doors to progress. In many fields—in plastics, in silicones, in resins, in insulating varnishes—General Electric is making new contributions to chemical knowledge. For more information, write Chemical Department, General Electric Company, Pittsfield, Massachusetts.



A message to students of chemistry and chemical engineering from

DR. W. R. WHITNEY

Former Director, General Electric Research Laboratory.

One of the most fascinating aspects of our work in developing new resins and insulating materials derives from the competitive position of our many products. For example, silicones and other new materials are already vying with older, established lines and with each other. With so many new and interesting developments, opportunities for younger technical men are most attractive.

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